APPENDIX D

Echo integration-trawl survey results for walleye pollock (*Theragra chalcogramma*) in the Gulf of Alaska during February and March, 2002

by Michael Guttormsen, Chris Wilson, and Sarah Stienessen

INTRODUCTION

Scientists from the Midwater Assessment and Conservation Engineering (MACE) Program of the Alaska Fisheries Science Center (AFSC) routinely conduct acoustic-trawl surveys in the Gulf of Alaska (GOA) to estimate walleye pollock (*Theragra chalcogramma*) distribution and abundance. Most of the effort has focused on the Shelikof Strait area, which has been surveyed annually since 1980, except in 1982 and 1999. With the exception of surveys in the Shumagin Islands area between 1994 and 1996 and in 2001, surveys outside the Shelikof Strait area have not indicated large amounts of pollock, although these efforts have been restricted temporally and spatially. Results presented here are from the most recent echo integration-trawl (EIT) surveys carried out between 10 and 16 February 2002 in the Shumagin Islands area, including Pavlof Bay and Sanak Trough, and between 12 and 26 March 2002 at three locations around Kodiak Island, including the Shelikof Strait area, the continental shelf break east of Chirikof Island, and Barnabas Trough.

METHODS

<u>Shumagin Islands Itinerary</u>

10 Feb	Embark scientists in Sand Point, AK; calibration of acoustic systems in Sanborn Harbor, AK
10-14 Feb	EIT survey of the Shumagin Islands
15 Feb	Exploratory surveys of Pavlof Bay and Sanak Trough
16 Feb	Arrive Dutch Harbor; disembark portion of scientific party; end of cruise

Shelikof Strait Itinerary

12 Mar	Embark scientists in Dutch Harbor, AK
12-14 Mar	Transit to the Shelikof Strait area
14-20 Mar	EIT survey of the Shelikof Strait area
21-24 Mar	EIT survey of the shelf break near Chirikof Island
24-25 Mar	EIT survey of Barnabas Trough
25 Mar	Acoustic system calibration in Ugak Bay, AK
26 Mar	Transit to Kodiak; disembark scientists; end of cruise

Acoustic Equipment

Acoustic data were collected with a Simrad EK 500[1] quantitative echo-sounding system (Bodholt et al. 1989, Bodholt and Solli 1992) on the NOAA ship *Miller Freeman*, a 66-m (216-foot) stern trawler equipped for fisheries and oceanographic research. Two split-beam transducers (38 kHz and 120 kHz) were mounted on the bottom of the vessel's centerboard at a nominal depth of 9 m. System electronics were permanently housed inside the vessel in a dedicated laboratory space. Echo integration data were sampled with a horizontal resolution of about 9 m and a vertical resolution of 0.5-2.0 m. Target strength (TS) data were collected simultaneously at both frequencies. Simrad BI500 echo integration and target strength data analysis software (Foote et al. 1991, Simrad 1993) were used to partition the acoustic information into pollock or other species groups. Results presented here are based on the 38-kHz data. Acoustic data were also collected at 38 and 120 kHz frequencies with a new acoustic system (Simrad EK60 echosounder, Sonardata Echologger, and Echoview post-processing software) to compare with the primary acoustic system. Comparison of the performance of the EK500 and EK60 38 and 120 kHz transceivers was facilitated by the use of a custom-designed multiplexer. The multiplexer generated master trigger pulses and switched transducers between transceivers on an alternate ping basis; this device also ensured that the 38 and 120 kHz transceivers were properly synchronized. For each frequency (38 or 120 kHz), the transducer was connected by the multiplexer to one transceiver for a complete trigger-transmit-receive cycle and was then connected to the other transceiver for the next trigger-transmit-receive cycle.

[1] Reference to trade names or commercial firms does not constitute U.S. Government endorsement.

The multiplexer ping interval was adjustable between 1 and 3 seconds, therefore the ping interval for one transceiver could be varied between 2 and 6 seconds.

A drifting buoy containing a Simrad EY500 echosounder, operating at 38 kHz, was deployed and recovered on an opportunistic basis to collect information of fish avoidance to radiated vessel noise. After the buoy was released in an area over fish echosign, the vessel steamed about 1.8 km (1 nmi) from the buoy and maintained that distance until the scientist in charge notified the bridge to begin free-running at normal survey speed along a course that took the vessel as close as possible past the buoy. The vessel continued steaming until 1.8 km past the buoy. Multiple passes were run past the buoy.

Trawl Gear

Midwater and near-bottom echosign was sampled with an Aleutian Wing 30/26 trawl (AWT). The AWT has full-mesh wings constructed of nylon with polyethylene in the codend and aft section of the body. The headrope and footrope each measured 81.7 m (268 ft). Mesh sizes tapered from 325.1 cm (128 in) in the forward section of the net to 8.9 cm (3.5 in) in the codend. The codend was fished with a 3.2-cm (1.25-in) liner during the Shumagin Islands survey and through 19 March during the Shelikof Strait survey. After 19 March, a 1.3-cm (0.5-in) liner was used. The AWT was fished with 82.3 m (270 ft) of 1.9-cm (0.75-in) diameter 8x19 (wire) non-rotational dandylines. The net was fished with 227-kg (500-lb) tom weights and 5 m^2 Fishbuster trawl doors [1,247 kg (2,750 lb) each]. Vertical and horizontal net opening and depth were monitored with a Wesmar third-wire netsounder system.

Demersal echosign was sampled with a poly nor'eastern bottom trawl (PNE) with roller gear. The PNE is a high-opening trawl equipped with roller gear, and was constructed with stretch mesh sizes that ranged from 13 cm (5 in) in the forward portion of the net to 89 mm (3.5 in) in the codend. The codend was fitted with a 32 mm (1.25 in) nylon mesh liner. The 27.2-m (89.1-ft) headrope held 21 floats [30-cm (12-in) diameter]. A 24.7-m (81-ft) chain fishing line was attached to the 24.9-m (81.6-ft) footrope which was constructed of 1-cm (0.4-in) 6 x 19 wire rope wrapped with polypropylene rope. The trawl was also rigged with triple 54.9-m (180-ft) galvanized wire rope dandylines. The roller gear was attached to the fishing line using chain toggles [2.9 kg (6.5 lb.) each] which were comprised of five links and one ring. The 24.2-m (79.5-ft) roller gear was constructed with 36-cm (14-in) rubber bobbins spaced 1.5 to 2.1 m (5 to 7 ft) apart. A solid string of 10-cm (4-in) rubber disks separated some of the bobbins in the center section of the roller gear. Two 5.9-m (19.5-ft) wire rope extensions with 10-cm (4-in) and 20-cm (8-in) rubber disks were used to span the two lower flying wing sections and were attached to the roller gear. The vertical net opening and depth were monitored with a Furuno netsounder system attached to the headrope. The net was fished with the 5 m^2 Fishbuster trawl doors.

Oceanographic Equipment

Physical oceanographic data collected during the cruise included temperature/depth profiles obtained with a Sea-Bird Electronics temperature-depth probe (SBE-39) attached to the trawl headrope and conductivity-temperature-depth (CTD) observations collected with a Sea-Bird CTD system at the calibration site. Sea surface temperature, salinity, and other environmental data were also collected and logged using the *Miller Freeman's* Scientific Computing System (SCS). Ocean current profile data were obtained using the vessel's centerboard-mounted acoustic Doppler current profiler system operating continuously at 150 kHz in the water-profiling mode.

Survey design

The Shumagin Islands survey was conducted between 10 and 14 February (Fig. 1). The survey began southwest of Nagai Island and proceeded north through West Nagai Strait and Unga Strait to the northern end of Stepovak Bay along parallel transects spaced 5.9 km (3.0 nmi) apart. The survey then progressed east through Shumagin Trough along transects spaced 9.3 km (5.0 nmi) apart. Exploratory surveys of Pavlof Bay and Sanak Trough were conducted on 15 February using a zig-zag trackline pattern. The survey of the Shelikof Strait area occurred between 14 and 20 March and covered the area from near Chirikof Island to about Cape Chiniak on the Alaska Peninsula (Fig. 2). The survey design consisted of parallel transects spaced 13.9 km (7.5 nmi) apart. After completion of the Shelikof Strait area work, a survey was conducted between 21 and 24 March, along the shelf break from about 18.5 km (10 nmi) east of Chirikof Island to the mouth of Barnabas Trough (Fig. 2). Fishing industry representatives had stated that this was an area where the commercial fleet was encountering significant quantities of pollock. The shelf-break trackline consisted of 19 transects spaced 11.1 km (6.0 nmi) apart, except along a single transect midway through the survey where the lines were reoriented to maintain a perpendicular alignment to the bathymetry. Barnabas Trough was surveyed on 24 and 25 March. The survey began near the final shelf-break transect and ended in Ugak Bay (Fig. 2). Transects were spaced 5.9 km (3.0 nmi) apart except for the first two transects, which were spaced 11.1 km (6.0 nmi) apart. Chiniak Trough was surveyed on 26 March using an exploratory zig-zag transect pattern.

Echo integration and trawl data were collected 24 hours a day. Acoustic system settings were based on results from standard sphere calibrations and instrument performance during previous surveys. Trawl hauls were conducted to identify echosign and to provide biological samples. Average trawling speed was approximately 1.5 m/s (3 kts). Standard catch sorting and biological sampling procedures were used to provide weight and number by species for each haul (MACE Sampling Manual[2]) . Pollock were sampled to determine sex, fork length, body weight, maturity, and ovary weight of selected females. For age determinations, pollock otoliths were collected and stored in 50% ethanol-water. An electronic motion-compensating scale was used to determine all weights taken from individual pollock specimens. Fork lengths were measured to the nearest cm and recorded with a Polycorder measuring device (a handheld data logger connected to a bar coded length reader, Sigler 1994) and downloaded into a desktop computer. Maturity was determined by visual inspection and categorized as immature, developing, pre-spawning, spawning, or post-spawning (MACE Sampling Manual). Additional samples of pollock tissue, stomach contents, ovaries were collected for ongoing research by NMFS scientists. Whole specimens of different species were also retained for a calorimetric prey study and AFSC Observer Program training specimens.

Standard sphere acoustic system calibrations were made before, during, and after the surveys to measure acoustic system performance for both echosounders at each frequency. During the calibrations, the *Miller Freeman* was anchored at bow and stern. Weather, sea state condition, and acoustic system settings were recorded. Two copper calibration spheres, 23 mm (120-kHz

[2] Midwater Assessment and Conservation Engineering (MACE) Sampling Manual. 2001. Unpublished document. Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle WA 98115.

sphere, TS = -40.3 dB) and 60 mm (38-kHz sphere, TS = -33.6 dB) diameters, were suspended below the transducers. With the spheres centered on the acoustic axis, split-beam TS and echo integration data were collected to determine acoustic system gain parameters. Each sphere was then pulled through its corresponding transducer acoustic beam to estimate the beam pattern characteristics using the Simrad program EKLOBES (Foote et al. 1987).

Data Analysis

Echo integration data were collected between 14 m of the surface and 0.5 m of the bottom, except where the bottom exceeded 1,000 m, the lower limit of data collection. Echosign data identified as pollock were stored in a relational database. Pollock length data were aggregated into analytical strata based on echosign type, geographic proximity of hauls, and similarity in size composition data. Estimates of pollock backscattering strength in the area represented by each stratum were then calculated. The echo integration values were summed and scaled using a previously derived relationship between target strength and fish length (TS = 20 Log FL - 66; Traynor 1996) and the length composition data, resulting in an estimate of numbers of pollock by size. Biomass estimates by size were calculated using the length-weight relationships calculated from the trawl data for the 4 areas sampled. Age-specific estimates of biomass and numbers will be generated after the otolith samples are aged.

Large numbers of eulachon (*Thaleichthys pacificus*) contaminated the acoustic returns from pollock in the Shelikof Strait area (see Results). The acoustic sign between these two species was apportioned using the catch weight of the two species in a manner as described by Guttormsen et al. (2001).

Relative estimation errors for the acoustic data were derived using a one-dimensional (1D) geostatistical method as described by Petitgas (1993), Williamson and Traynor (1996), and Rivoirard et al. (2000). Relative estimation error is defined as the ratio of the square root of the estimation variance to the estimate of "acoustic abundance". Geostatistical methods were used for computation of error because they account for the observed spatial structure. These errors quantify only transect sampling variability. Other sources of error (e.g., target strength, trawl sampling, error associated with ageing) are not included.

RESULTS AND DISCUSSION

Calibration

Five acoustic system calibrations were conducted; one during the pre-season gear trials in Port Susan, WA, and the rest occurring before, during, and after the surveys (Table 1). No significant differences in gain parameters or transducer beam pattern characteristics were observed for the 38 kHz collection system.

Shumagin Islands area

Biological sampling

Biological data were collected from 1 bottom trawl and 5 midwater trawl hauls (Table 2, Fig. 1). Pollock dominated the midwater trawl catches in both weight (99.7%) and numbers (99.6%; Table 3). In the single bottom trawl, pollock was also the dominant species caught. Arrowtooth flounder (*Atherestes stomias*) was the next most abundant species caught (2.3% by weight and 2.6% by number; Table 4).

Distribution

Acoustic data were collected along 808 km (437 nmi) of transect tracklines in the Shumagin Islands. A distributional plot of the acoustic backscattering attributed primarily to pollock indicated that the densest aggregations were distributed off Renshaw Point and east of Unga Island in West Nagai Strait (Fig. 3). Pollock were generally within 50 m of the sea floor. The small amount of pollock echosign observed outside of these two areas was distributed mostly off Swedania Point and in Shumagin Trough.

Trawl hauls conducted off Renshaw Point and east of Unga Island contained mostly adult[3] pollock (Fig. 4A-B). The fish were slightly larger off Renshaw Point than those in West Nagai Strait. The size composition of fish caught off Swedania Point was dominated by 2-year old

[3]Because age data are not yet available for the Shumagin Islands area survey, length ranges were used as a proxy for age based on length at age from previous surveys. Pollock between 9-16 cm FL are considered age 1, most pollock between 17-25 cm FL are considered age 2, most pollock from 26-35 cm FL are considered age 3, and most pollock exceeding 35 cm FL are considered adults.

pollock (Fig. 4C). A net reel equipment failure prevented trawling operations from occurring in Stepovak Bay and Shumagin Trough.

The unweighted maturity composition for males longer than 40 cm was 0% immature, 2% developing, 72% mature pre-spawning, 15% spawning, and 11% spent (Fig. 5). The maturity composition of the relatively few females longer than 40 cm large that were caught was 0% immature, 10% developing, 78% pre-spawning, 5% spawning, and 8% spent. Comparison of the female maturity composition with previous Shumagin surveys conducted in mid-February suggests that the timing of peak spawning has varied. For example, the percent of the female pollock classified as either "spawning" or "spent" in 2002 (13%) was greater that in 1995 (6%) but substantially lower than in 1996 (37%) and 2001 (45%).

Female pollock were estimated to be 50% mature at 44 cm FL (Fig. 6), which was similar to the 1995 (45 cm FL), 1996 (42 cm FL), and 2001 (42 cm FL) surveys. The mean GSI (gonad weight/total body weight) for mature pre-spawning females of 0.17 (Fig. 7) was similar to the mean GSIs of 0.19 and 0.16 obtained during the 1996 and 2001 surveys, respectively, but higher than the mean GSI of 0.12 obtained during the 1995 survey.

Abundance

The abundance of pollock in the Shumagin Islands area is estimated to be 202.1 million pollock weighing 135,600 metric tons (t). The estimates do not include echosign detected in Shumagin Trough; however, the underestimate is negligible given the relatively low densities in that area. The relative estimation error based on the 1D geostatistical analysis was 27.1%. The high relative estimation error may be an indication that the survey design in the Shumagin Islands could be improved by narrowing the transect spacing or ensuring that the trackline run orthogonal to the bathymetry.

Inference about abundance trends is difficult to make for the Shumagin Islands area because a suitable time series does not exist. The abundance of pre-spawning pollock in 1995 and 2001 are the only estimates comparable to 2002. The 1994 effort was an exploratory survey that occurred in March well after spawning has occurred, and the areas surveyed in 1994 and 1996 were much smaller than in 1995 and 2001. The 2002 biomass is about 25% higher than the 2001 estimate of 108,300 t and about one-half of the 1995 estimate of 290,100 t. Whether these differences reflect variation in the timing of peak spawning or an actual changes in abundance is unknown. Additionally, the Shumagin Islands surveys do not appear to be good predictors of future pollock abundance. For example, over one-half of the adult pollock numbers in 2001 consisted of the 1993, 1994, and 1995 year classes; however, these year classes were detected in low numbers or were absent entirely as juveniles during the 1994, 1995, and 1996 surveys (Fig. 8).

Pavlof Bay

Acoustic data were collected along 44 km (24 nmi) of transect tracklines in Pavlof Bay. Significant densities of echosign believed to be pollock were observed off Black Point (Fig. 3). No confirmation trawls were conducted, however, because of the net reel malfunction.

Sanak Trough

Acoustic data were collected along 109 km (59 nmi) of transect tracklines in Sanak Trough. Dense echosign believed to be pollock was detected in much of the northern part of the trough and on the eastern ends of the southern part (Fig. 3). The total amount of backscattering was about one-third of that detected in the Shumagin Islands.

Shelikof Strait area

Biological sampling

Biological data were collected from 1 bottom trawl and 18 midwater trawl hauls (Table 5, Fig. 3). Pollock dominated the midwater trawl catches in both weight and numbers (Table 6). Eulachon was next most abundant species caught, accounting for 12.3% of the catch by weight and 40.0% by number. Eulachon were caught primarily in trawl hauls conducted south of Cape Kekurnoi that targeted near-bottom echosign. In the single bottom trawl, pollock was the dominant species caught. Arrowtooth flounder (*Atherestes stomias*, 11.8% by weight) and shrimp (17.6% by number) were the next most abundant species caught (Table 7).

Distribution

Acoustic data were collected along 1,432 km (773 nmi) of transect tracklines in the Shelikof Strait area. The densest echosign attributed to near-bottom pollock occurred from about 30 nmi northwest of Chirikof Island to about Cape Kekurnoi (Fig. 9). Similar to the 2001 survey but unlike most other Shelikof Strait surveys, very little echosign was detected beyond Katmai Bay along the west side of the Strait, where the bulk of the mature pre-spawning pollock are usually found. Significant quantities of juvenile pollock (mostly 3-year old fish[4]) formed well-defined midwater layers during the day at about 150 m depth and dispersed layers from about 50-175 m at night (Fig. 10). Most of these layers extended from slightly north of the Semidi Islands to about Middle Cape. About 50% of the total midwater layer echosign occurred on transects 11 and 12.

Length composition

Pollock in the mid-water layer were predominantly 3 years old (Fig. 11A). No pollock exceeding 40 cm FL were caught in this layer. The majority of pollock in the near-bottom layer were also 3 years old, although the contribution of 2 years olds and adult pollock was greater than in the mid-water layers (Fig. 11B). The few 1-year old pollock that were observed in the survey area were caught in near-bottom tows conducted in the southernmost portion of the survey area.

Maturity

The unweighted maturity composition of male pollock longer than 40 cm FL was <1% immature, 5% developing, 74% mature pre-spawning, 5% spawning, and 16% spent (Fig. 12). The unweighted maturity composition for females longer than 40 cm FL was 0% immature, 16% developing, 84% pre-spawning, 0% spawning, and <1% spent. The percent of females in the

[4]Because age data are not yet available for the Shelikof Strait survey, length ranges were used as a proxy for age based on length at age from previous surveys. Pollock between 9-16 cm FL are considered age 1, most pollock between 17-23 cm FL are considered age 2, most pollock from 24-30 cm FL are considered age 3, and most pollock exceeding 30 cm FL are considered adults.

spawning and spent stage of maturity was similar in 2000 and 2001 (3% in both years) but substantially lower than in 1998 (17%), 1997 (15%), and 1996 (23%). Female pollock were estimated to be 50% mature at 42 cm (Fig. 13), which is similar to recent survey estimates but markedly larger than estimates from the early 1980s. The mean GSI (gonad weight/total body weight, Fig. 14) for mature pre-spawning females of 0.12 was similar to the mean GSI from the 2001 survey but lower than the mean GSIs (0.14-0.19) reported for other recent (1992-2000) Shelikof surveys, which suggests that the fish may have spawned relatively later in the Shelikof Strait area this year.

Abundance

The abundance of pollock in the Shelikof Strait area is estimated to be 1.3 billion pollock weighing 229,100 t. This estimate reflects the subtraction of 13% of the total backscattering to account for the contribution of eulachon in the acoustic returns. Results from surveys prior to 1992 did not account for eulachon contamination. The relative estimation error based on the 1D geostatistical analysis was 6.9%.

The pollock biomass in Shelikof Strait declined dramatically in the 1980s, falling from 2,768,000 t in 1981 to 290,000 t in 1989 (Table 8, Fig. 15). The biomass gradually rose in the 1990s, reaching 748,000 t in 1996. Since then, the abundance has been declining. The 2002 biomass estimate is 38% lower than the 2001 estimate and is the lowest in survey history.

The pollock size composition for 2002 is consistent with results from recent surveys. The 1994 year class represented the largest estimate of 1-year old pollock (10.0 billion fish) in the history of the Shelikof Strait area EIT surveys. This year class continued to dominate abundance estimates through the 1998 survey, and for the 2002 survey is represented by fish in the 50-55 cm FL range, although in small numbers (Fig. 16). The 1999 year class (estimated as 4.3 billion fish in 2000) was the second largest 1-year old estimate in survey history and continues to dominate the abundance estimates as 3-year old fish in 2002, both in numbers (1.0 billion fish) and biomass (152,600 mt). In contrast, the estimate of 6 million 1-year old pollock in 2002 was the second lowest in survey history.

Acoustic buoy

The acoustic buoy was deployed once over juvenile pollock near Middle Cape. The *Miller Freeman* made 14 passes within 5-20 m (16-66 ft) of the buoy during a night-time deployment. Hauls 17-19 were associated with this effort. Analysis of the data is in progress.

Shelf break area

Biological sampling

Biological data were collected from 9 midwater trawl hauls (Table 9, Fig. 2). Adult pollock were the dominant species caught, both in weight (91.1%) and in numbers (34.0%). Grenadiers (4.6%) and shortraker rockfish (*Sebastes borealis*, 2.2%) were the next most abundant species caught by weight, and myctophids (lanternfishes, 31.6%), shrimp (19.7%), squid (6.9%), and eulachon (3.8%) were the next most abundant species caught by numbers.

Distribution

Acoustic data were collected along 833 km (450 nmi) of transect tracklines in the shelf break area. Most echosign attributed to mid-water layers of pollock occurred between 300-500 m depth within the two shelf-break bights between Chirikof Island and Barnabas Trough over bottom depths of 300-800 m. However, the layer occasionally was detected over bottom depths as shallow as 200 m and or in excess of 1,500 m (Fig. 17). Substantial acoustic backscattering was attributed to myctophids and other micronekton species, which occurred along the offshore portions of the transects at about 200-300 m depth. This myctophid scattering layer, which occurred mostly over bottom depths from 800 to deeper than 1,500 m, may have obscured very low densities of pollock.

Length composition

Adult fish dominated the size composition of pollock caught in the shelf-break area (Fig. 11C). Over 99% of the pollock exceeding 40 cm FL. The size composition of the shelf-break pollock was similar to the adult pollock caught in Shelikof Strait (Fig. 11B).

Maturity

The unweighted maturity composition for male pollock longer than 40 cm FL was <1% immature, 1% developing, 69% mature pre-spawning, 10% spawning, and 20% spent (Fig. 18). The unweighted maturity composition for females longer than 40 cm FL was 0% immature, 2% developing, 97% pre-spawning, <1% spawning, and 1% spent. Female pollock were estimated to be 50% mature at 41 cm (Fig. 19). The mean GSI for mature pre-spawning females was 0.15 (Fig. 20).

Abundance

The abundance of pollock in the shelf break area is estimated to be 76.5 million pollock weighing 82,100 t. The relative estimation error based on the 1D geostatistical analysis was 12.2%.

Barnabas Trough

Acoustic data were collected along 417 km (225 nmi) of transect tracklines in Barnabas Trough. Virtually no pollock were detected except in Ugak Bay (Fig. 21), where the single mid-water trawl caught only 2- and 3-year old pollock (Fig. 11D). Virtually all of the catch was pollock (Table 10). The abundance of pollock in Barnabas Trough is estimated to be 12.1 million pollock weighing 1,300 t.

The acoustic buoy was deployed once over the pollock echosign in Ugak Bay. The *Miller Freeman* made 6 passes within 5-15 m (16-49 ft) of the buoy during a night-time deployment. Analysis of the data is in progress.

While en route to Kodiak to disembark the scientific party, 56 km (30 nmi) of zig-zag tracklines were conducted in Chiniak Trough (Fig. 2). About 2-3 nmi of moderate echosign was detected near Cape Chiniak. Due to time constraints, however, no hauls were conducted to determine the species composition of this echosign.

ACKNOWLEDGMENTS

The authors would like to thank the officers and crew of the NOAA ship *Miller Freeman* for their contribution to the successful completion of this work.

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SCIENTIFIC PERSONNEL

Name	Sex/Nation	Position	Organization	Dates
Michael Guttormsen	M/USA	Chief Scientist	MACE	10-16 Feb
Michael Brown	M/USA	Computer Specialist	MACE	10-16 Feb
Neal Williamson	M/USA	Fish. Biologist	MACE	10-16 Feb
Sarah Stienessen	F/USA	Fish. Biologist	MACE	10-16 Feb
Steve de Blois	M/USA	Fish. Biologist	MACE	10-16 Feb
William Floering	M/USA	Fish. Biologist	MACE	10-16 Feb
Stephane Gauthier	M/Canadian	Fish. Biologist	UW	10-16 Feb
Mike Bancroft	M/USA	Naval Architect	JJMA	10-16 Feb
Michael Guttormsen	M/USA	Chief Scientist	MACE	12-26 Mar
Chris Wilson	M/USA	Fish. Biologist	MACE	12-26 Mar
Steve de Blois	M/USA	Fish. Biologist	MACE	12-26 Mar
Sarah Stienessen	F/USA	Fish. Biologist	MACE	12-26 Mar
Annette Brown	F/USA	Fish. Biologist	FOCI	12-26 Mar
Guy Fleischer	M/USA	Fish. Biologist	FRAM	12-26 Mar
Lawrence Hufnagle	M/USA	Fish. Biologist	FRAM	12-26 Mar
Elliot Hazen	M/USA	Fish. Biologist	UW	12-26 Mar
Richard Redman	M/USA	Teacher-at-sea	OLA	12-26 Mar

FOCI - Fisheries Oceanographic Coordinated Investigations, AFSC, Seattle, WA

FRAM - Fishery Resource Analysis and Monitoring Division, Northwest Fisheries Science Center, Seattle, WA

JJMA - John J. McMullen Associates, Inc., Pascagoula, MS

MACE - Midwater Assessment and Conservation Engineering Program, AFSC, Seattle, WA

OLA - NOAA Office of Legislative Affairs, Teachers at Sea Program, Washington, D.C.

UW - University of Washington, Seattle, WA

Table 1. Results from acoustic system calibrations using standard sphere techniques conducted before, during, and after the late winter/early spring 2002 echo integration-trawl surveys of walleye pollock in the Gulf of Alaska.

Date	Location	Frequency (kHz)	Water temp (°C) At transducer[1]	Water temp (°C) At sphere	Sphere range from transducer (m)	TS gain (dB)	s_V gain (dB)	3-dB Beam width (deg) Along	3-dB Beam width (deg) Athwart	Angle offset (deg) Along	Angle offset (deg) Athwart
17-Jan	Port Susan, WA	38	9.3	9.3	32.1	25.6	25.4	6.92	6.83	-0.10	0.01
		120	9.3	9.3	27.3	27.1	27.6	6.67	6.50	-0.19	0.09
10-Feb	Sanborn Harbor, AK	38	2.5	3.1	-	-	-	6.90	6.78	-0.10	-0.02
		120	2.5	3.1	-	-	-	6.76	6.71	-0.26	0.19
18-Feb	Captains Bay, AK	38	1.8	3.7	28.2	26.1	25.8	6.90	6.79	-0.11	-0.01
		120	-	-	-	-	-	-	-	-	-
10-Mar	Captains Bay, AK	38	3.2	3.2	29.1	26.1	25.6	6.94	6.82	-0.10	0.00
		120	3.2	3.2	23.6	26.0	26.2	7.01	6.93	0.14	0.04
25-Mar	Ugak Bay, AK	38	3.3	3.4	26.6	26.0	25.6	6.79	6.94	-0.09	0.01
		120	3.3	3.4	-	-	-	6.86	6.84	-0.08	0.09
	System settings during surveys	38	-	-	-	26.0	25.7	6.90	6.80	-0.08	0.03
		120	-	-	-	27.1	27.1	6.70	6.70	-0.23	-0.14

[1]The transducer was located approximately 9 m below the water surface.

Note: Gain and beam pattern terms are defined in the "Operator Manual for Simrad EK500 Scientific Echo Sounder (1993)" available from Simrad Subsea A/S , Strandpromenaden 50, P.O. Box 111, N-3191 Horten, Norway.

Table 2. Summary of trawl and catch data from the 2002 pollock echo integration-trawl survey of the Shumagin Islands area in the Gulf of Alaska.

Haul	Gear[1]	Date	Time	Duration	Start position		Depth (m)		Temp. (deg. C)		Pollock catch		Other catch	
No.	type	(GMT)	(GMT)	(minutes)	Lat (N)	Long (W)	gear	bottom	gear	surface	kg	number	kg	number
1	awt	11 Feb	23:05	15	55 10.48	160 14.30	157	185	3.1	3.1	4,695.3	5,929	18.9	37
2	awt	12 Feb	13:52	5	55 28.63	160 26.18	115	140	2.1	3.2	976.5	12,576	0.0	0
3	awt	12 Feb	22:10	7	55 31.89	160 16.93	153	190	2.7	3.5	3,337.2	3,160	12.8	8
4	pne	13 Feb	0:18	11	55 31.89	160 16.98	205	205	2.7	3.6	445.9	363	19.1	22
5	awt	13 Feb	13:46	2	55 34.96	160 14.96	167	194	3.2	3.5	2,858.1	3,231	1.9	44
6	awt	13 Feb	15:55	2	55 34.40	160 19.14	133	190	2.6	3.2	554.3	2,961	8.9	30

[1]awt = Aleutian wing trawl, pne = poly nor'eastern bottom trawl.

Table 3. Summary of catch by species in midwater trawls conducted during the 2002 pollock echo integration-trawl survey of the Shumagin Islands area.

Common name	Scientific name	Weight (kg)	Percent	Numbers	Percent
Walleye pollock	*Theragra chalcogramma*	12,421.4	99.7%	27,857	99.6%
Smooth lumpsucker	*Aptocyclus ventricosus*	18.5	0.1%	12	<0.1%
Arrowtooth flounder	*Atheresthes stomias*	12.8	0.1%	8	<0.1%
Pacific cod	*Gadus macrocephalus*	7.7	0.1%	2	<0.1%
Eulachon	*Thaleichthys pacificus*	2.8	<0.1%	71	0.3%
Pacific halibut	*Hippoglossus stenolepis*	0.3	<0.1%	1	<0.1%
Flathead sole	*Hippoglossoides elassodon*	0.3	<0.1%	1	<0.1%
Shrimp unident.	Decapoda	0.1	<0.1%	18	0.1%
Northern shrimp	*Pandalus borealis*	<0.1	<0.1%	6	<0.1%
Total		12,463.9		27,976	

Table 4. Summary of catch by species in the bottom trawl conducted during the 2002 pollock echo integration-trawl survey of the Shumagin Islands area.

Common name	Scientific name	Weight (kg)	Percent	Numbers	Percent
Walleye pollock	*Theragra chalcogramma*	445.9	95.9%	363	94.3%
Arrowtooth flounder	*Atheresthes stomias*	10.7	2.3%	10	2.6%
Pacific cod	*Gadus macrocephalus*	5.3	1.1%	1	0.3%
Smooth lumpsucker	*Aptocyclus ventricosus*	2.4	0.5%	2	0.5%
Chrysaora jellyfish	Chrysaora	0.4	0.1%	1	0.3%
Eulachon	*Thaleichthys pacificus*	0.3	0.1%	7	1.8%
Starfish unident.		<0.1	<0.1%	1	0.3%
Total		465.0		385	

Table 5. Summary of trawl and catch data from the 2002 pollock echo integration-trawl surveys of the Shelikof Strait area, the Gulf of Alaska shelf break near Chirikof Island, and Barnabas Trough.

Haul	Gear[1]	Date		Time	Duration	Start position				Depth (m)		Temp. (deg. C)		Pollock catch		Other catch	
No.	type	(GMT)	Area	(GMT)	(minutes)	Lat (N)		Long (W)		gear	bottom	gear	surface	kg	number	kg	number
1	awt	14 Mar	Shelikof	18:05	30	55	40.02	156	10.23	243	250	3.9	5.4	200.3	1,374	102.3	1,514
2	awt	15 Mar	Shelikof	1:44	28	55	49.74	156	21.64	166	246	4.1	4.5	1,180.2	7,603	0.2	3
3	awt	15 Mar	Shelikof	12:11	12	56	12.25	156	15.84	236	246	3.7	5.1	641.5	4,615	220.0	6,101
4	awt	15 Mar	Shelikof	17:49	5	56	19.33	156	14.61	168	271	3.8	4.5	1,459.8	9,714	0.2	1
5	awt	15 Mar	Shelikof	22:12	6	56	25.11	155	59.81	225	233	4.1	4.4	383.6	1,836	268.8	4,555
6	awt	16 Mar	Shelikof	11:36	15	56	40.83	156	1.05	284	303	3.5	4.7	1,365.6	8,644	207.3	5,269
7	awt	16 Mar	Shelikof	18:44	1	56	45.92	155	44.35	128	275	3.9	4.1	1,015.4	7,280	1.7	3
8	awt	17 Mar	Shelikof	0:43	20	56	54.32	155	48.19	290	301	3.6	5.6	1,603.0	7,921	1,173.0	8,968
9	awt	17 Mar	Shelikof	11:25	10	57	8.65	155	40.14	270	280	3.4	4.5	677.1	2,906	625.2	15,802
10	awt	17 Mar	Shelikof	17:04	15	57	13.18	155	21.20	126	251	3.9	4.2	1,157.6	8,433	0.3	1
11	awt	17 Mar	Shelikof	23:11	13	57	22.22	155	26.95	259	274	4.2	5.9	1,897.5	6,907	452.5	8,844
12	awt	18 Mar	Shelikof	7:37	6	57	36.47	155	24.21	173	244	3.4	4.2	425.0	3,091	1.5	28
13	pne	18 Mar	Shelikof	14:20	11	57	43.84	154	54.84	252	252	3.2	4.7	341.9	473	83.4	350
14	awt	18 Mar	Shelikof	18:30	25	57	49.10	154	45.11	238	247	3.9	4.5	396.3	1,150	35.8	812
15	awt	19 Mar	Shelikof	3:06	20	57	50.78	154	4.38	216	223	4.0	4.4	1,260.7	3,884	163.3	4,159
16	awt	19 Mar	Shelikof	15:10	31	58	16.08	153	31.09	109	176	4.1	4.2	183.9	1,040	3.1	15
17	awt	20 Mar	Shelikof	10:29	60	57	21.40	155	10.35	48	239	3.5	3.5	4.8	25	0.8	285
18	awt	20 Mar	Shelikof	12:57	14	57	20.91	155	8.33	119	240	3.7	4.1	581.4	3,767	15.6	216
19	awt	20 Mar	Shelikof	17:17	11	57	21.11	155	9.06	137	239	3.7	4.2	363.1	2,106	--	--
20	awt	21 Mar	Shelf break	4:26	25	55	40.06	155	8.27	426	513	4.5	4.4	278.6	294	5.3	405
21	awt	21 Mar	Shelf break	12:37	3	55	44.95	154	56.43	336	829	4.5	5.1	271.3	257	2.9	266
22	awt	21 Mar	Shelf break	20:27	30	55	34.69	154	35.77	282	983	4.3	4.8	1.2	1	3.3	277
23	awt	22 Mar	Shelf break	1:18	10	55	58.06	154	37.05	401	550	4.5	4.6	240.0	226	2.9	629
24	awt	22 Mar	Shelf break	17:29	31	56	8.00	153	42.20	273	301	4.4	5.3	8.9	8	35.9	840
25	awt	22 Mar	Shelf break	23:51	25	55	54.14	153	36.75	412	682	4.5	4.5	764.1	643	20.2	1,110
26	awt	23 Mar	Shelf break	5:54	31	55	59.29	153	25.23	434	662	4.3	4.8	441.8	424	88.3	474
27	awt	23 Mar	Shelf break	15:17	18	56	16.74	153	8.89	349	560	3.6	5.0	439.4	354	98.9	677
28	awt	24 Mar	Shelf break	1:43	21	56	22.26	152	32.40	465	823	4.7	4.5	765.5	672	55.4	914
29	awt	25 Mar	Barnabas	8:56	3	57	25.32	152	37.58	59	105	3.3	3.6	653.9	6,250	0.1	9

[1]awt = Aleutian wing trawl, pne = poly nor'eastern bottom trawl.

Table 6. Summary of catch by species in midwater trawls conducted during the 2002 pollock echo integration-trawl survey of the Shelikof Strait area.

Common name	Scientific name	Weight (kg)	Percent	Numbers	Percent
Walleye pollock	*Theragra chalcogramma*	14,796.8	81.9%	82,240	59.2%
Eulachon	*Thaleichthys pacificus*	2,221.1	12.3%	55,472	40.0%
Pacific sleeper shark	*Somniosus pacificus*	847.0	4.7%	8	<0.1%
Smooth lumpsucker	*Aptocyclus ventricosus*	92.7	0.5%	75	0.1%
Arrowtooth flounder	*Atheresthes stomias*	55.6	0.3%	82	0.1%
Chinook salmon	*Oncorhynchus tshawytscha*	16.8	0.1%	11	<0.1%
Magistrate armhook squid	*Berryteuthis magister*	9.3	0.1%	43	<0.1%
Squid unident.	Teuthoidea	6.9	<0.1%	66	<0.1%
Pacific cod	*Gadus macrocephalus*	6.1	<0.1%	1	<0.1%
Rougheye rockfish	*Sebastes aleutianus*	5.0	<0.1%	3	<0.1%
Shrimp unident.	Decapoda	2.5	<0.1%	417	0.3%
Coho salmon	*Oncorhynchus kisutch*	1.9	<0.1%	8	<0.1%
Shortraker rockfish	*Sebastes borealis*	1.8	<0.1%	1	<0.1%
Jellyfish unident.	Scyphozoa	1.3	<0.1%	1	<0.1%
Flathead sole	*Hippoglossoides elassodon*	1.1	<0.1%	5	<0.1%
Sidestripe shrimp	*Pandalopsis dispar*	1.0	<0.1%	105	0.1%
Pacific ocean perch	*Sebastes alutus*	0.8	<0.1%	1	<0.1%
Euphausiids	Euphausiacea	0.3	<0.1%	208	0.1%
Sablefish	*Anoplopoma fimbria*	0.2	<0.1%	1	<0.1%
Capelin	*Mallotus villosus*	0.1	<0.1%	59	<0.1%
Comb jelly unident.	Ctenophora	0.1	<0.1%	6	<0.1%
Sharpchin rockfish	*Sebastes zacentrus*	0.1	<0.1%	1	<0.1%
Longsnout prickleback	*Lumpenella longirostris*	0.1	<0.1%	1	<0.1%
Sculpin unident.	Cottidae	<0.1	<0.1%	1	<0.1%
		18,068.6		138,816	

Table 7. Summary of catch by species in the bottom trawl conducted during the 2002 pollock echo integration-trawl survey of the Shelikof Strait area.

Common name	Scientific name	Weight (kg)	Percent	Numbers	Percent
Walleye pollock	*Theragra chalcogramma*	341.9	80.4%	472	57.4%
Arrowtooth flounder	*Atheresthes stomias*	49.3	11.6%	122	14.8%
Flathead sole	*Hippoglossoides elassodon*	10.8	2.5%	28	3.4%
Pacific cod	*Gadus macrocephalus*	4.4	1.0%	1	0.1%
Big skate	*Raja binoculata*	3.9	0.9%	1	0.1%
Dover sole	*Microstomus pacificus*	3.4	0.8%	5	0.6%
Sablefish	*Anoplopoma fimbria*	2.6	0.6%	1	0.1%
Shortraker rockfish	*Sebastes borealis*	2.0	0.5%	2	0.2%
Magistrate armhook squid	*Berryteuthis magister*	1.4	0.3%	2	0.2%
Shrimp unident.	Decapoda	1.3	0.3%	145	17.6%
Eulachon	*Thaleichthys pacificus*	1.3	0.3%	19	2.3%
Rex sole	*Glyptocephalus zachirus*	1.3	0.3%	13	1.6%
Sea pen unident.	Pennatulacea	1.2	0.3%	5	0.6%
Chionoecetes bairdi	*Chionoecetes bairdi*	0.3	0.1%	4	0.5%
Jellyfish unident.	Scyphozoa	0.2	0.0%	1	0.1%
Hermit crab unident.	Paguridae	0.1	0.0%	1	0.1%
Total		425.4		822	

Table 8. Estimates of pollock biomass (in metric tons) for the Shelikof Strait area echo integration-trawl surveys.

Year	Biomass
1981	2,785,700
1982	No survey
1983	2,278,100
1984	1,757,100
1985	1,175,200
1986	585,700
1987	No estimate
1988	301,700
1989	290,500
1990	374,700
1991	380,300
1992	681,400
1993	408,200
1994	467,300
1995	725,200
1996	747,800
1997	570,800
1998	488,300
1999	No survey
2000	389,300
2001	369,600
2002	229,100

Table 9. Summary of catch by species in midwater trawls conducted during the 2002 pollock echo integration-trawl survey of the Gulf of Alaska shelf break near Chirikof Island.

Common name	Scientific name	Weight (kg)	Percent	Numbers	Percent
Walleye pollock	*Theragra chalcogramma*	3,210.8	91.1%	2,879	34.0%
Grenadier unident.	Macrouridae	161.4	4.6%	54	0.6%
Shortraker rockfish	*Sebastes borealis*	79.2	2.2%	23	0.3%
Eulachon	*Thaleichthys pacificus*	19.1	0.5%	320	3.8%
Myctophidae	Myctophidae	16.7	0.5%	2,679	31.6%
Arrowtooth flounder	*Atheresthes stomias*	8.4	0.2%	3	<0.1%
Pacific ocean perch	*Sebastes alutus*	7.5	0.2%	12	0.1%
Squid unident.	Teuthoidea	6.5	0.2%	588	6.9%
Shrimp unident.	Decapoda	2.9	0.1%	1,670	19.7%
Smooth lumpsucker	*Aptocyclus ventricosus*	2.7	0.1%	3	<0.1%
Magistrate armhook squid	*Berryteuthis magister*	2.5	0.1%	4	<0.1%
Salps unident.	Thaliacea	1.8	0.1%	5	0.1%
Jellyfish unident.	Scyphozoa	1.7	<0.1%	64	0.8%
Northern smoothtongue	*Leuroglossus schmidti*	1.2	<0.1%	59	0.7%
Capelin	*Mallotus villosus*	0.5	<0.1%	51	0.6%
Chrysaora jellyfish	Chrysaora	0.5	<0.1%	1	<0.1%
Coho salmon	*Oncorhynchus kisutch*	0.3	<0.1%	1	<0.1%
Pacific lamprey	*Lampetra tridentata*	0.2	<0.1%	5	0.1%
Pacific viperfish	Chauliodus macouni	<0.1	<0.1%	28	0.3%
Euphausiids	Euphausiacea	<0.1	<0.1%	18	0.2%
Viperfish unident.	Chauliodontidae	<0.1	<0.1%	3	<0.1%
Tubeshoulder unident.	Searsiidae	<0.1	<0.1%	1	<0.1%
Total		3,523.9		8,471	

Table 10. Summary of catch by species in midwater trawls conducted during the 2002 pollock echo integration-trawl survey of Barnabas Trough.

Common name	Scientific name	Weight (kg)	Percent	Numbers	Percent
Walleye pollock	*Theragra chalcogramma*	653.9	>99.9%	6,250	99.9%
Squid unident.	Teuthoidea	0.1	<0.1%	4	0.1%
Myctophidae	Myctophidae	<0.1	<0.1%	2	<0.1%
Capelin	*Mallotus villosus*	<0.1	<0.1%	1	<0.1%
Northern smoothtongue	*Leuroglossus schmidti*	<0.1	<0.1%	1	<0.1%
Shrimp unident.	Decapoda	<0.1	<0.1%	1	<0.1%
Total		654.0		6,259	

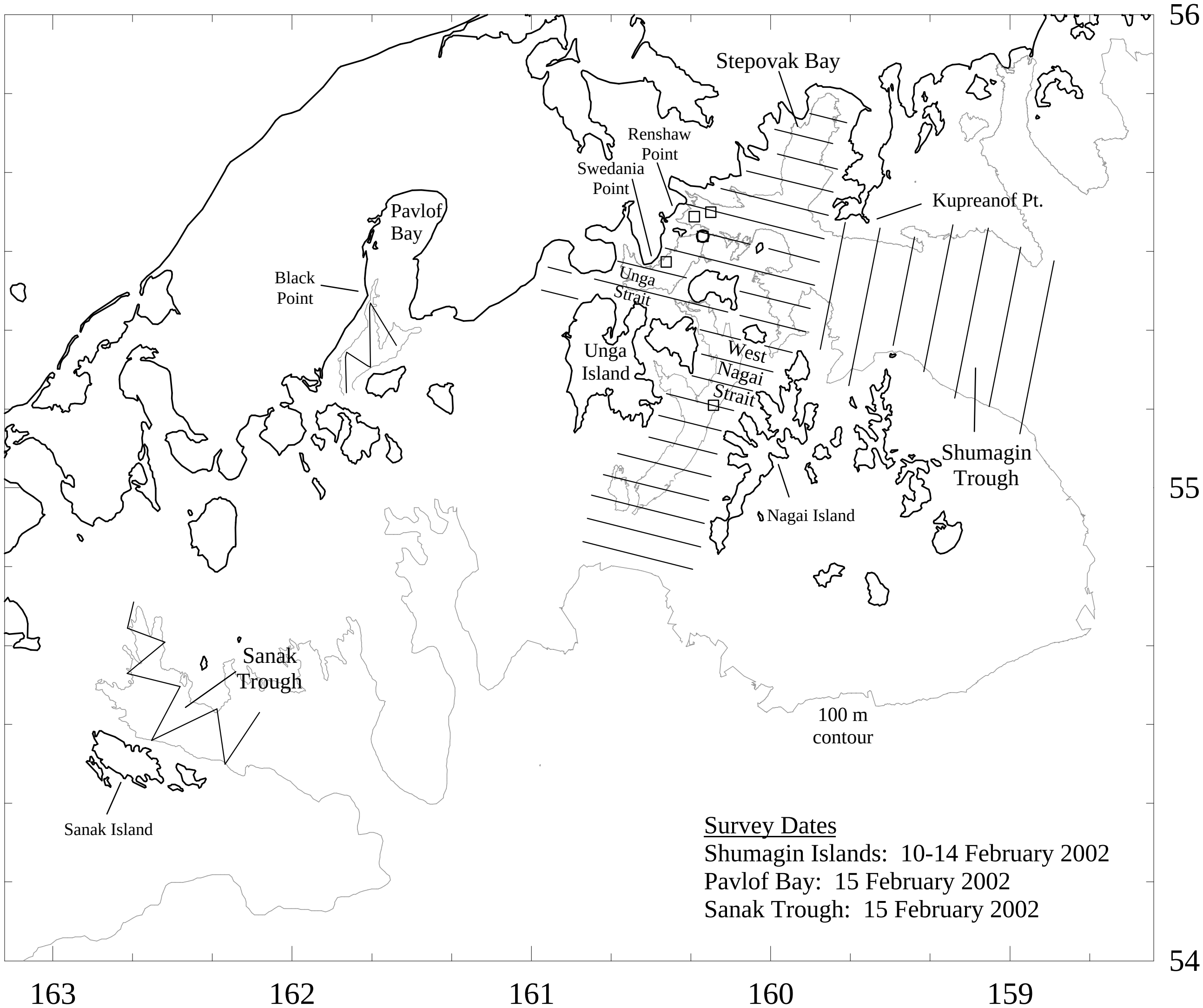

Figure 1. Transect lines and locations of midwater (square) and bottom (circle) trawl hauls conducted during the 2002 echo integration-trawl surveys of the Shumagin Islands area, Pavlof Bay, and Sanak Trough.

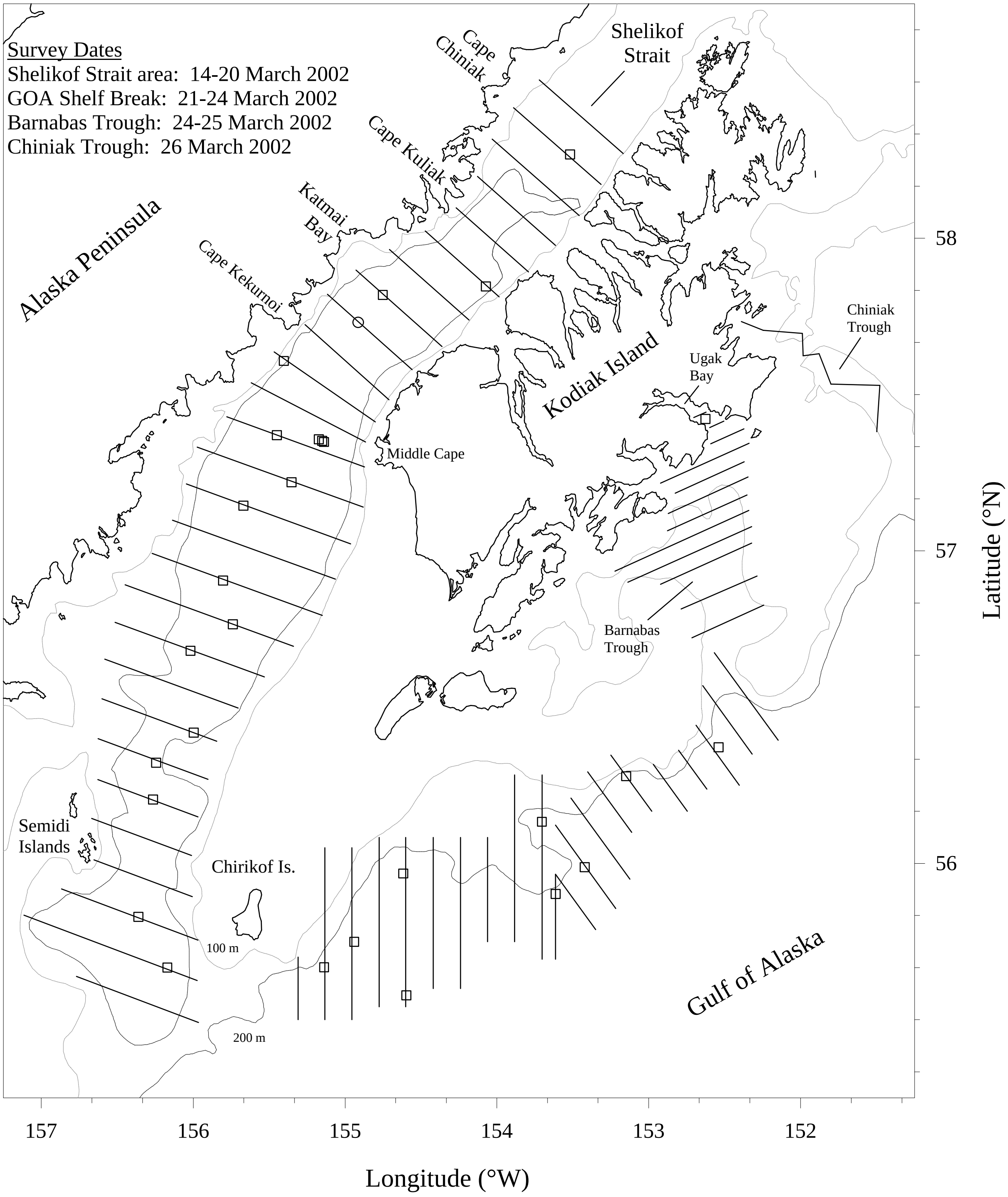

Figure 2. Transect lines and locations of midwater (square) and bottom (circle) trawl hauls conducted during the winter 2002 echo integration-trawl survey of the Shelikof Strait area, the Gulf of Alaska shelf break near Chirikof Island, and Barnabas and Chiniak Troughs.

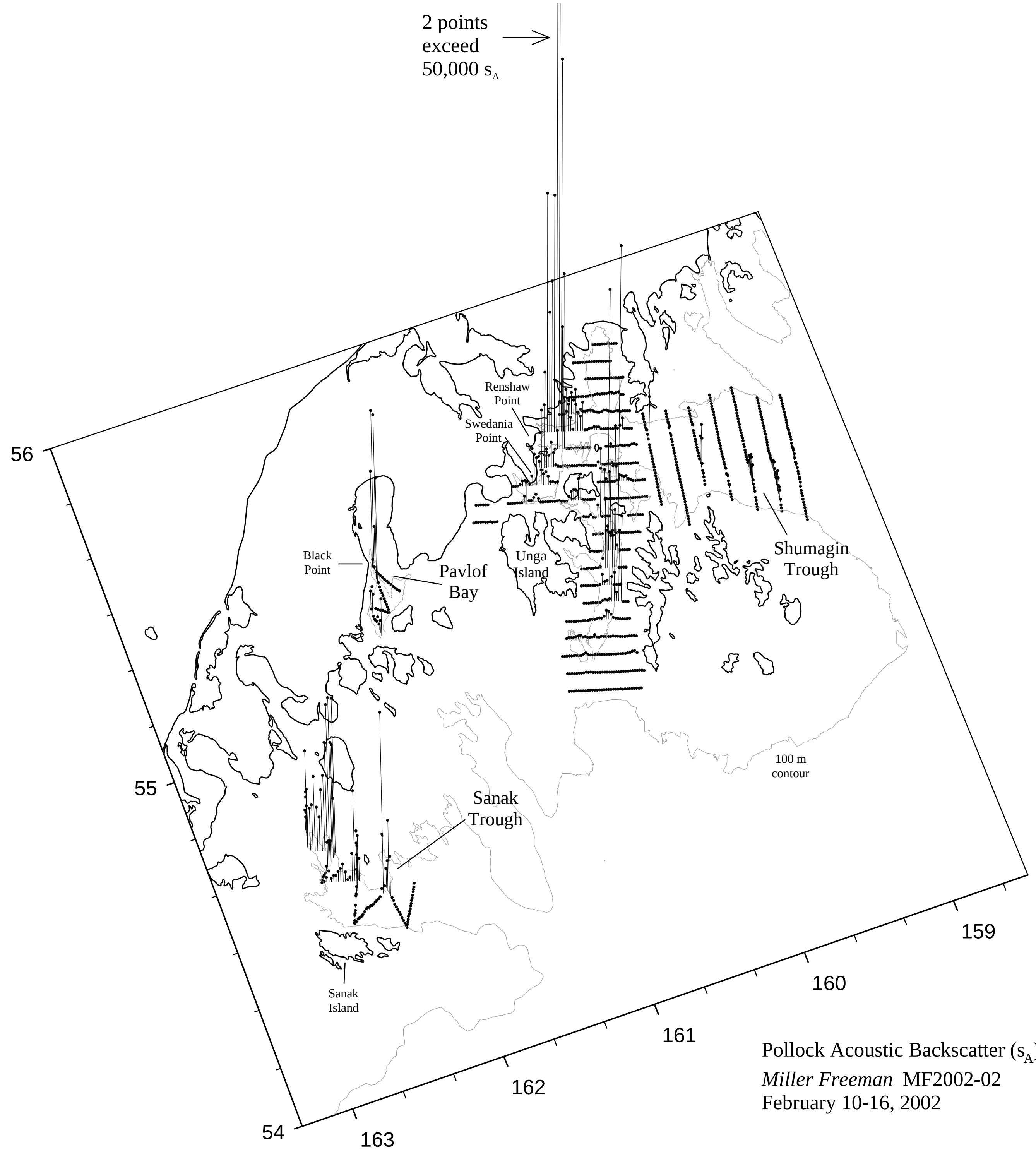

Figure 3. Relative backscattering (s_A) attributed primarily to pollock along tracklines during the winter 2002 echo integration-trawl surveys of the Shumagin Islands, Pavlof Bay, and Sanak Trough in the Gulf of Alaska.

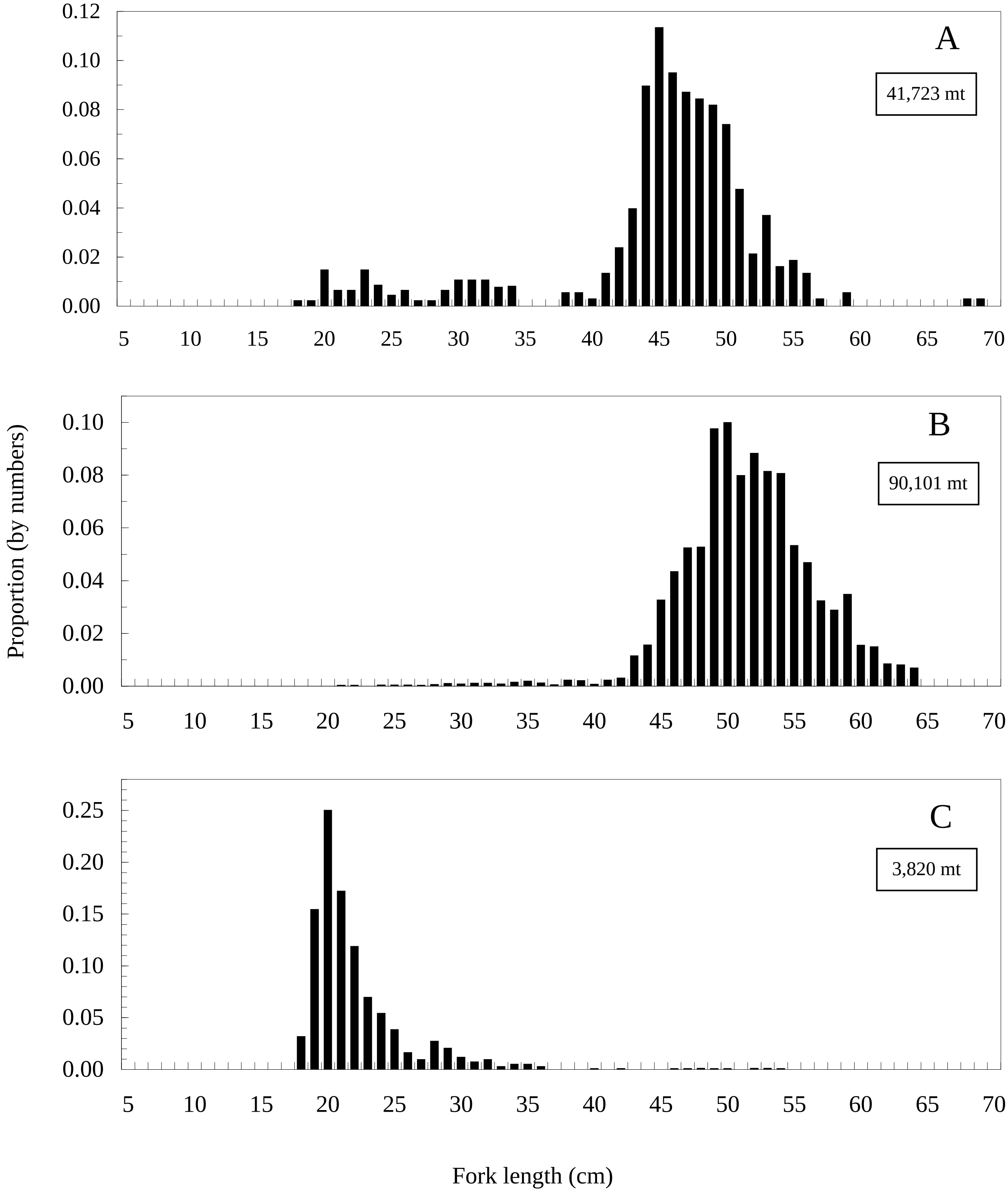

Figure 4. The size distribution of pollock (by numbers of fish) and biomass (in metric tons (t)) in (A) West Nagai Strait, (B) off Renshaw Point, and (C) off Swedania Point for the 2002 echo integration-trawl survey of the Shumagin Islands area.

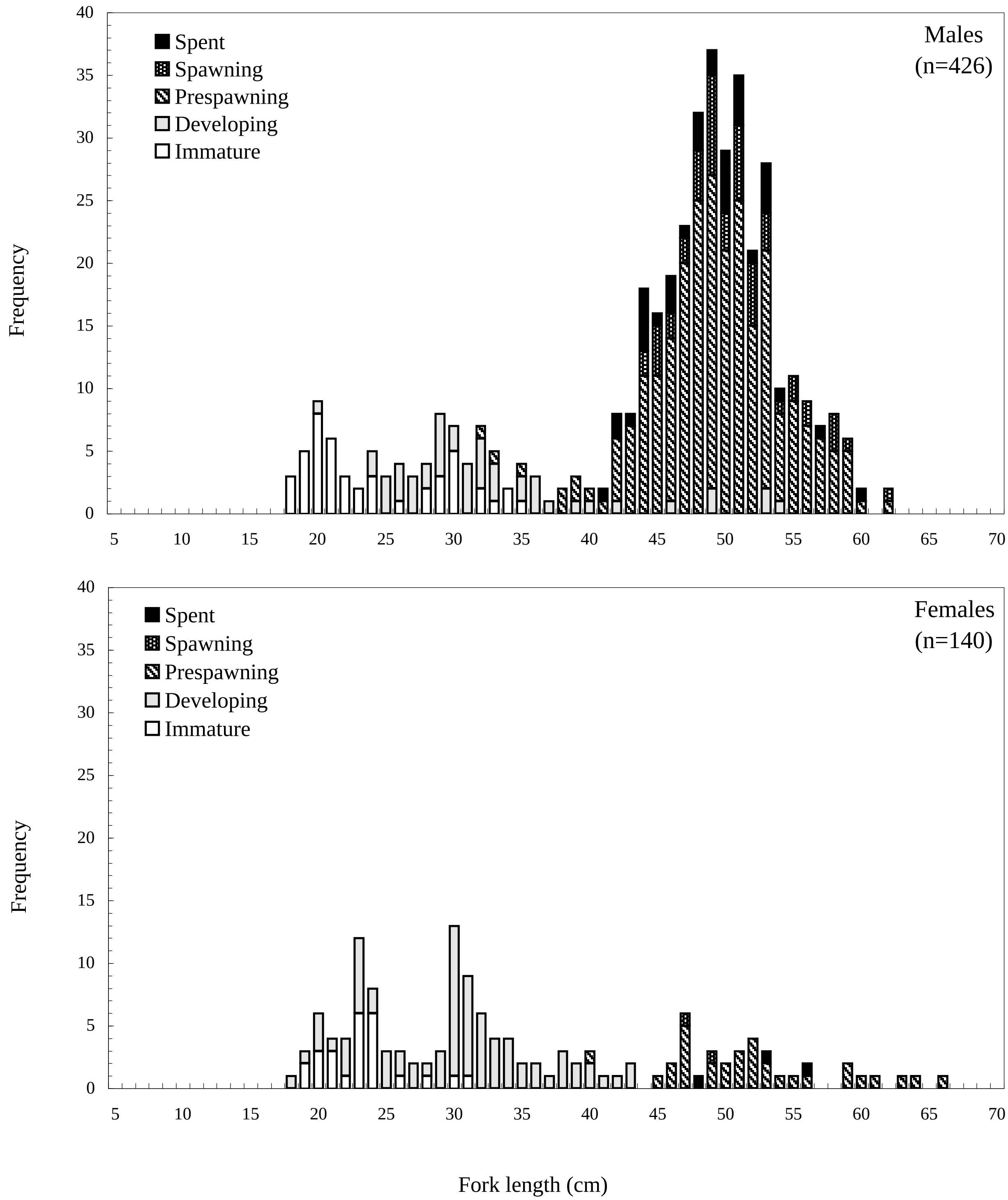

Figure 5. Maturity-length composition for male and female pollock taken during the winter 2002 echo integration-trawl survey of the Shumagins Islands area of the Gulf of Alaska. The maturity-length composition does not necessarily represent the population size composition.

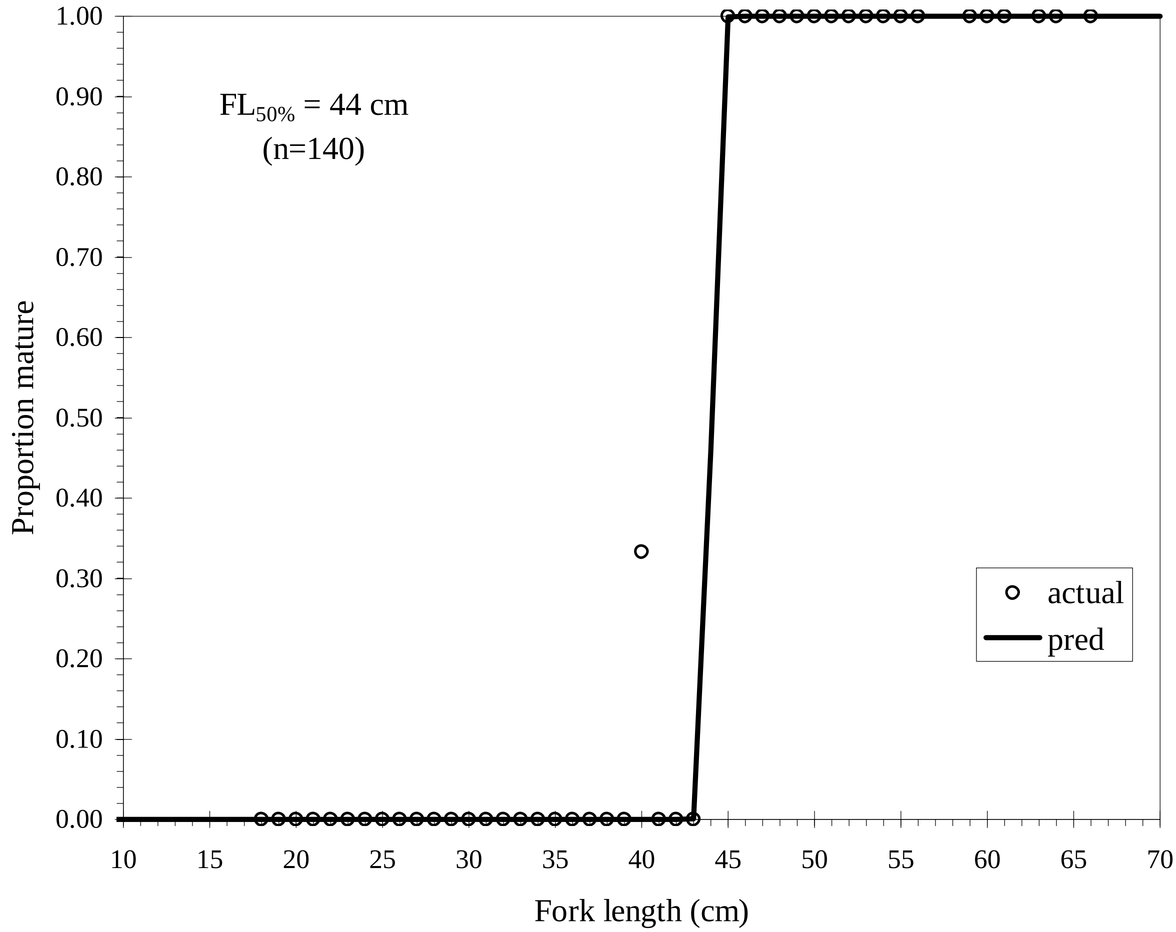

Figure 6. Fitted logistic function and proportion mature by 1-cm length class for female pollock collected in the Shumagin Islands area during the 2001 echo integration-trawl survey of the Gulf of Alaska.

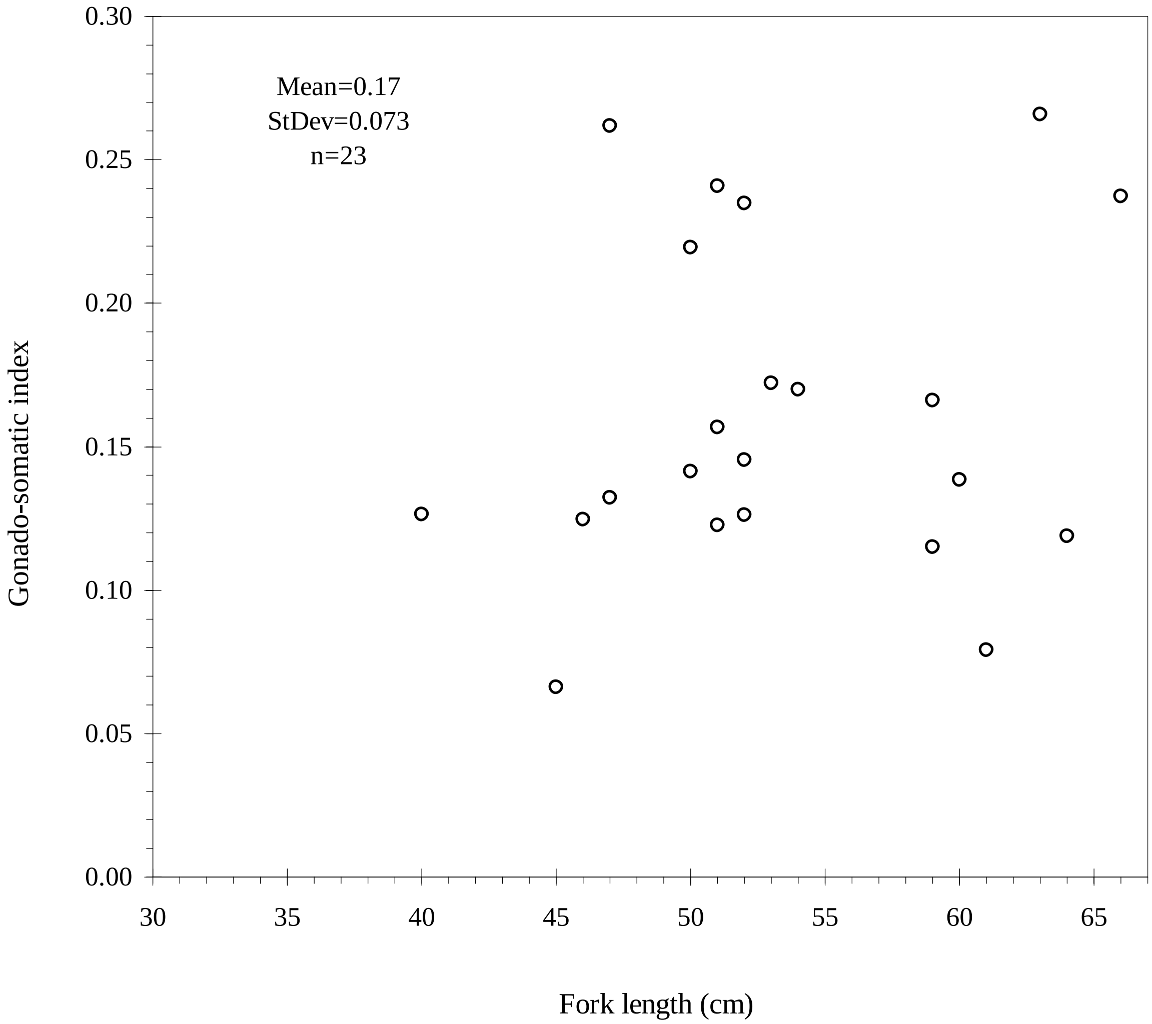

Figure 7. Pollock gonadosomatic index plotted by 1-cm length class for mature females caught during the 2002 echo integration-trawl survey of the Shumagin Islands area.

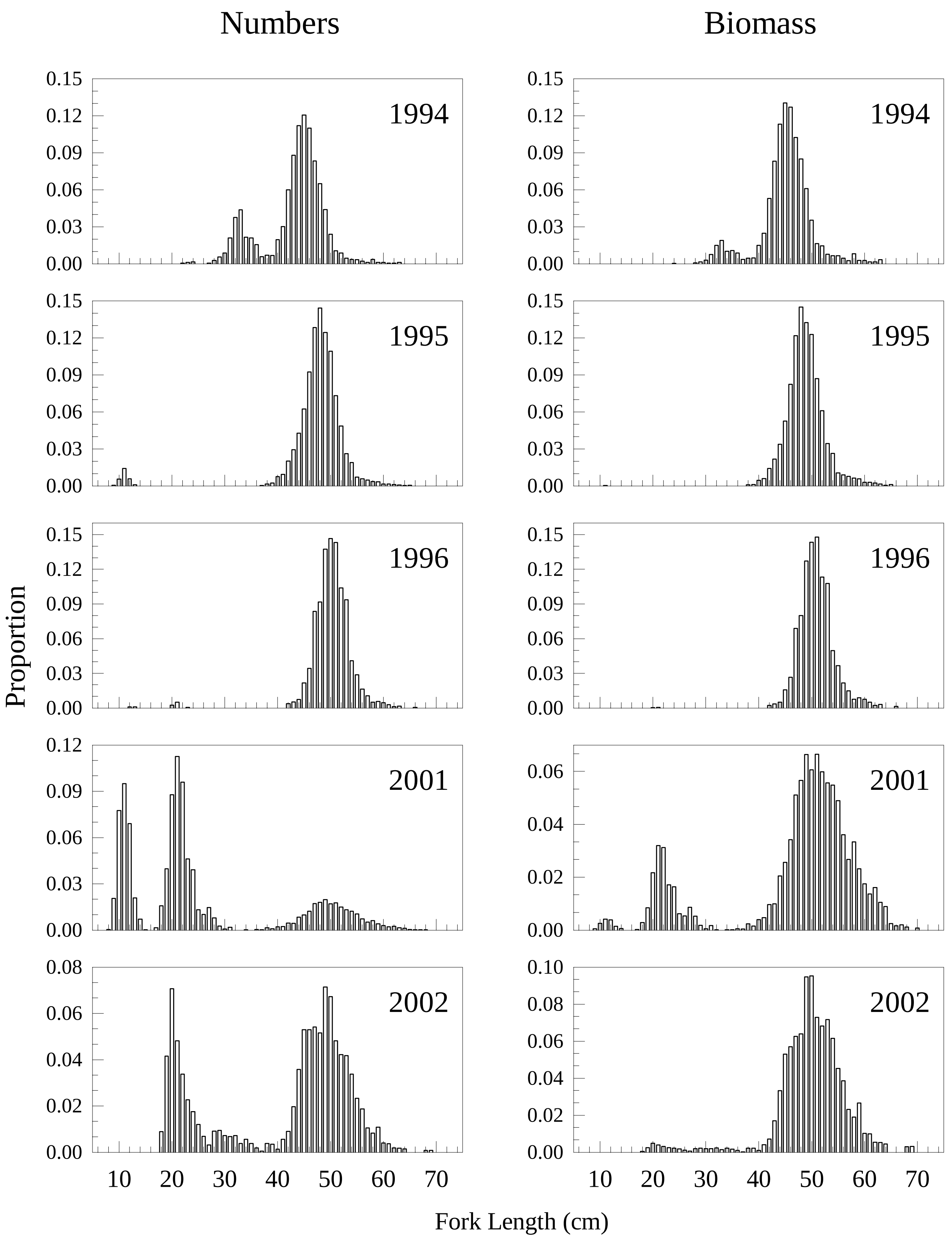

Figure 8. Pollock size composition estimates for the Shumagin Islands area based on echo integration-trawl surveys during 1994-96 and 2001-02.

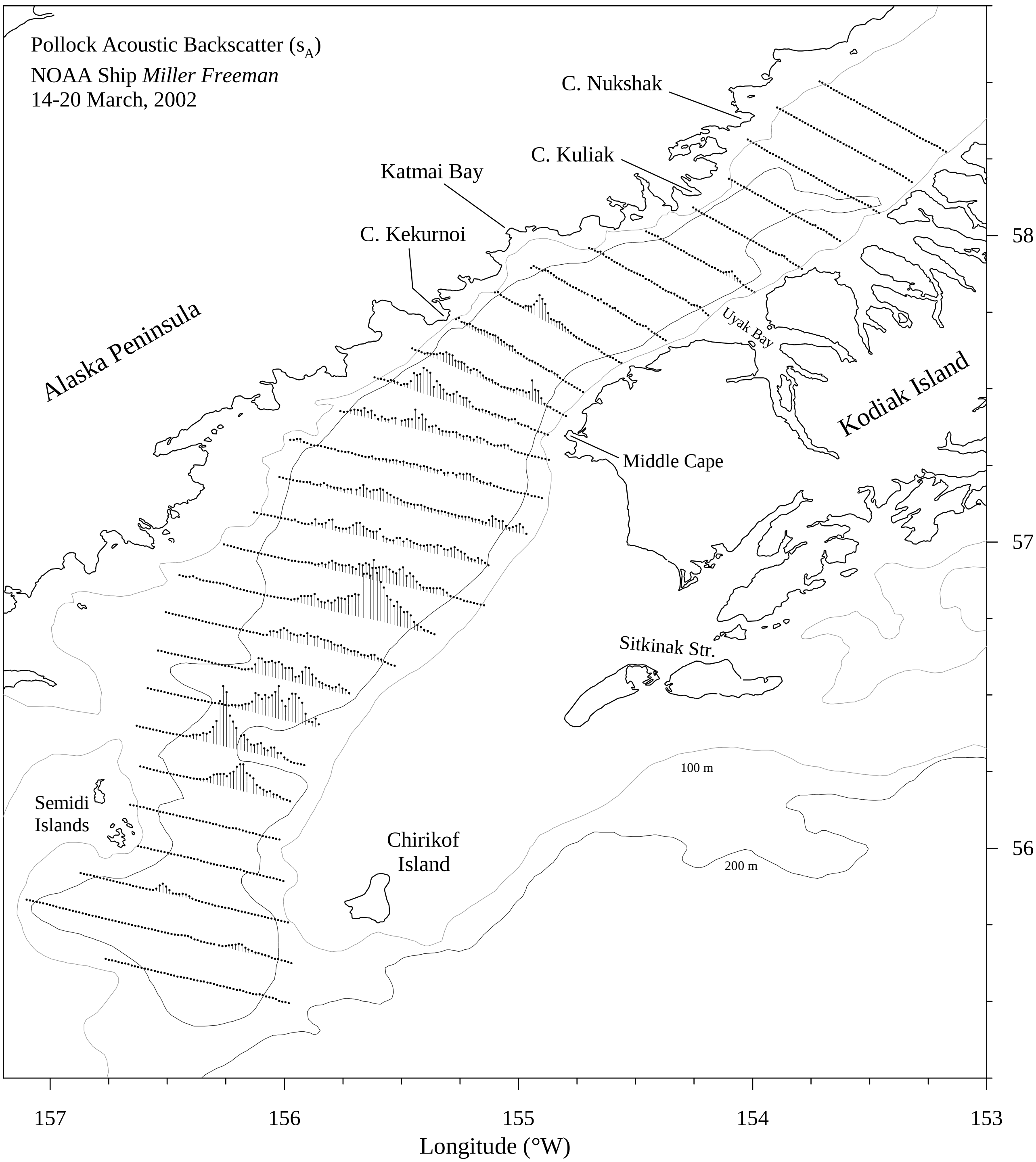

Figure 9. Relative pollock backscatter (s_A) attributed to near-bottom layers along transects from the 2002 winter echo integration-trawl survey of the Shelikof Strait area.

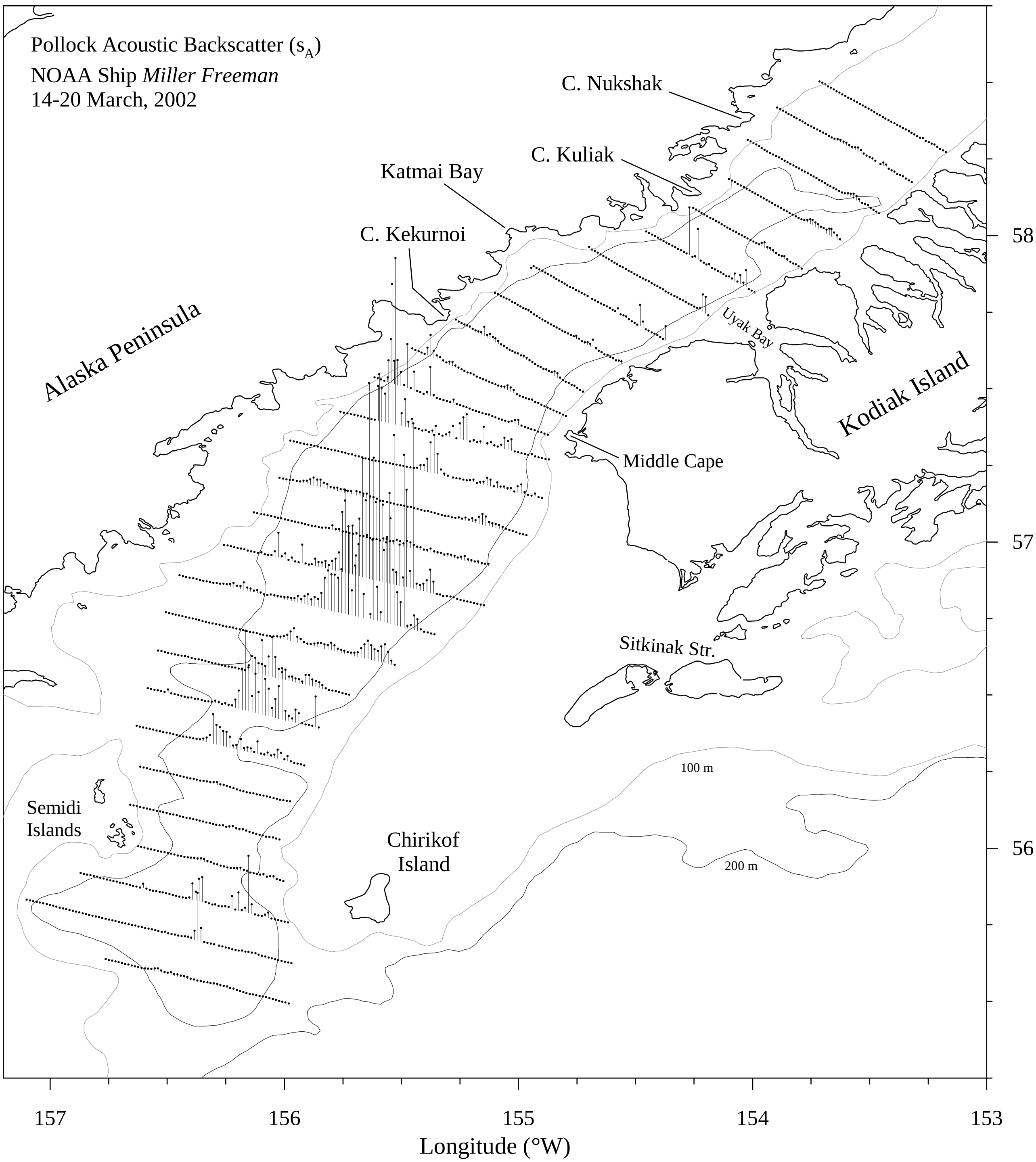

Figure 10. Relative pollock backscatter (s_A) attributed to mid-water layers (primarily subadult pollock) along transects from the 2002 winter echo integration-trawl survey of the Shelikof Strait area.

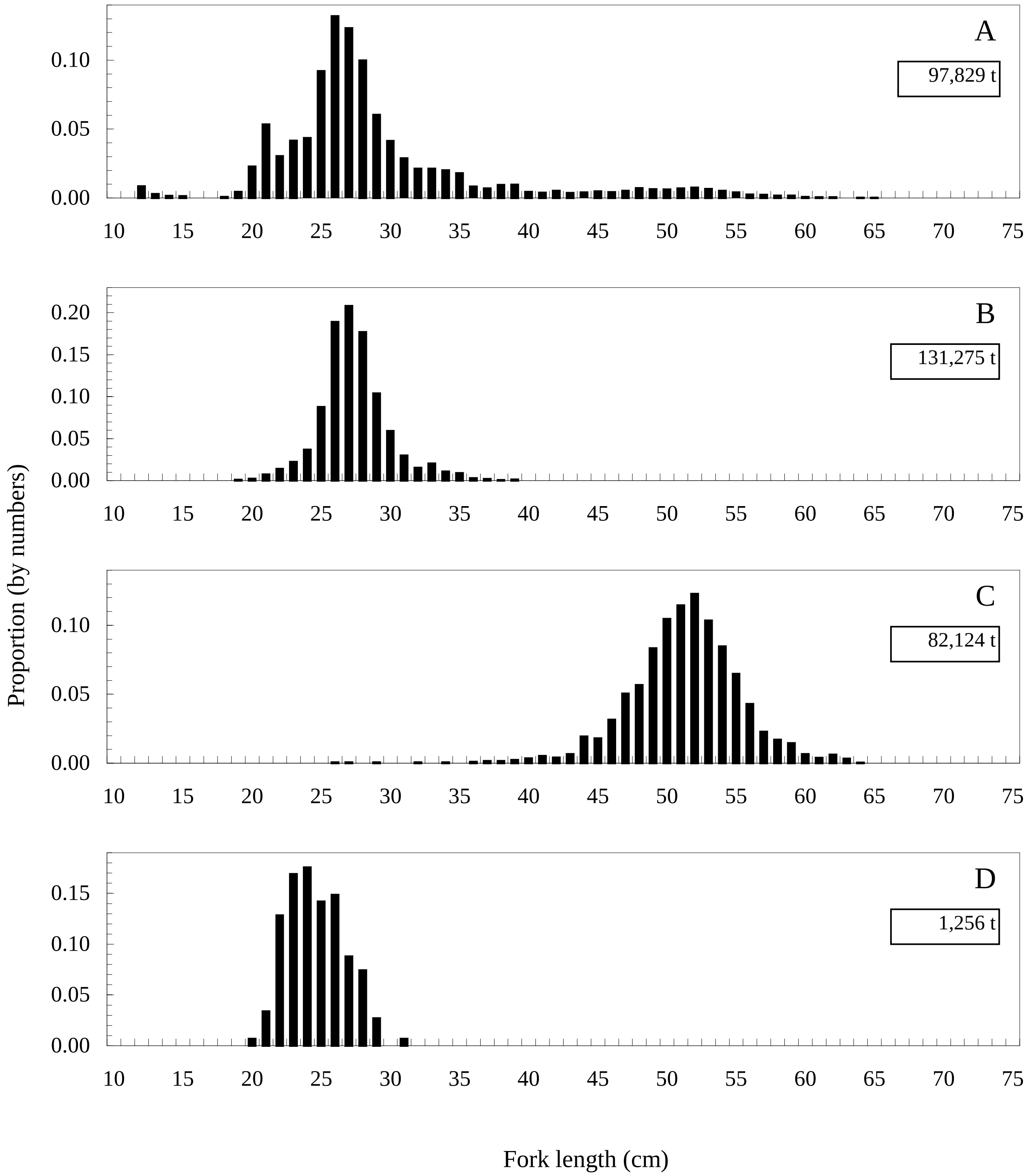

Figure 11. Estimates of pollock size distribution (numbers of fish) and biomass (metric tons (t)) of (A) the midwater layer and (B) the near-bottom layer in the Shelikof Strait area, and (C) the Gulf of Alaska shelf-break area near Chirikof Island and (D) Barnabas Trough for the late winter/early spring 2002 echo integration-trawl surveys in the Gulf of Alaska.

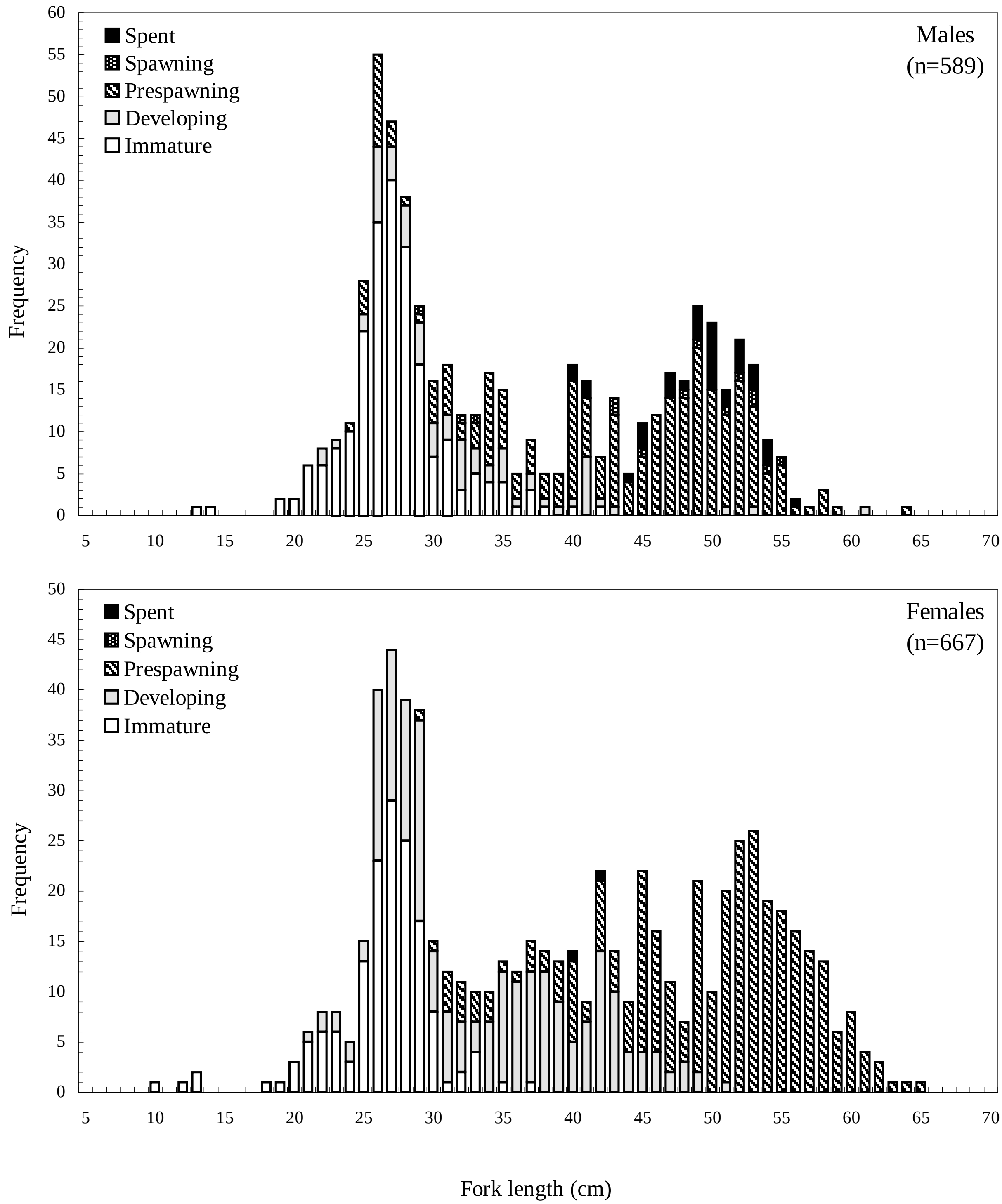

Figure 12. Maturity-length composition for male and female pollock taken during the 2002 echo integration-trawl survey of the Shelikof Strait area. The maturity-length composition does not necessarily represent the population size composition.

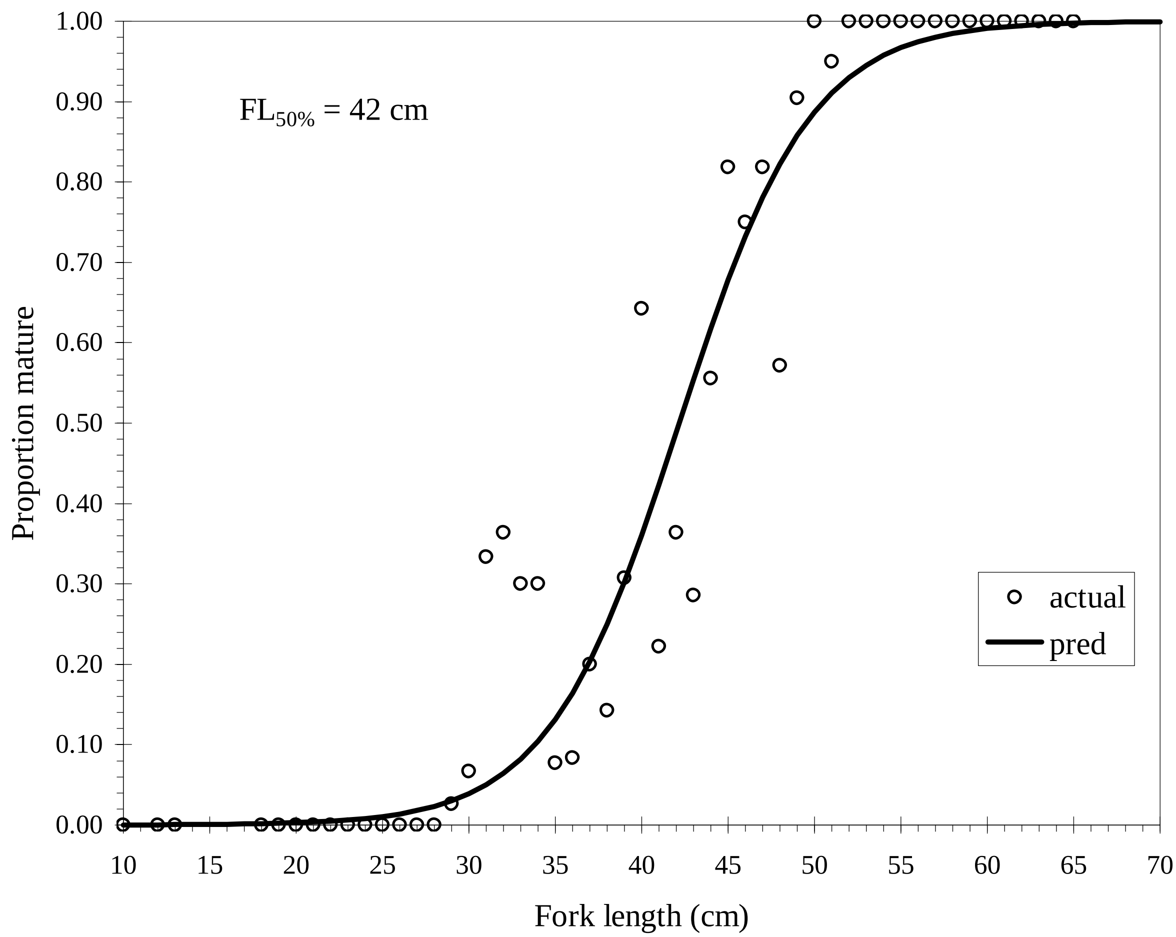

Figure 13. Fitted logistic function and proportion mature by 1-cm size class for female pollock collected in the Shelikof Strait area during the 2002 echo integration-trawl survey of the Gulf of Alaska.

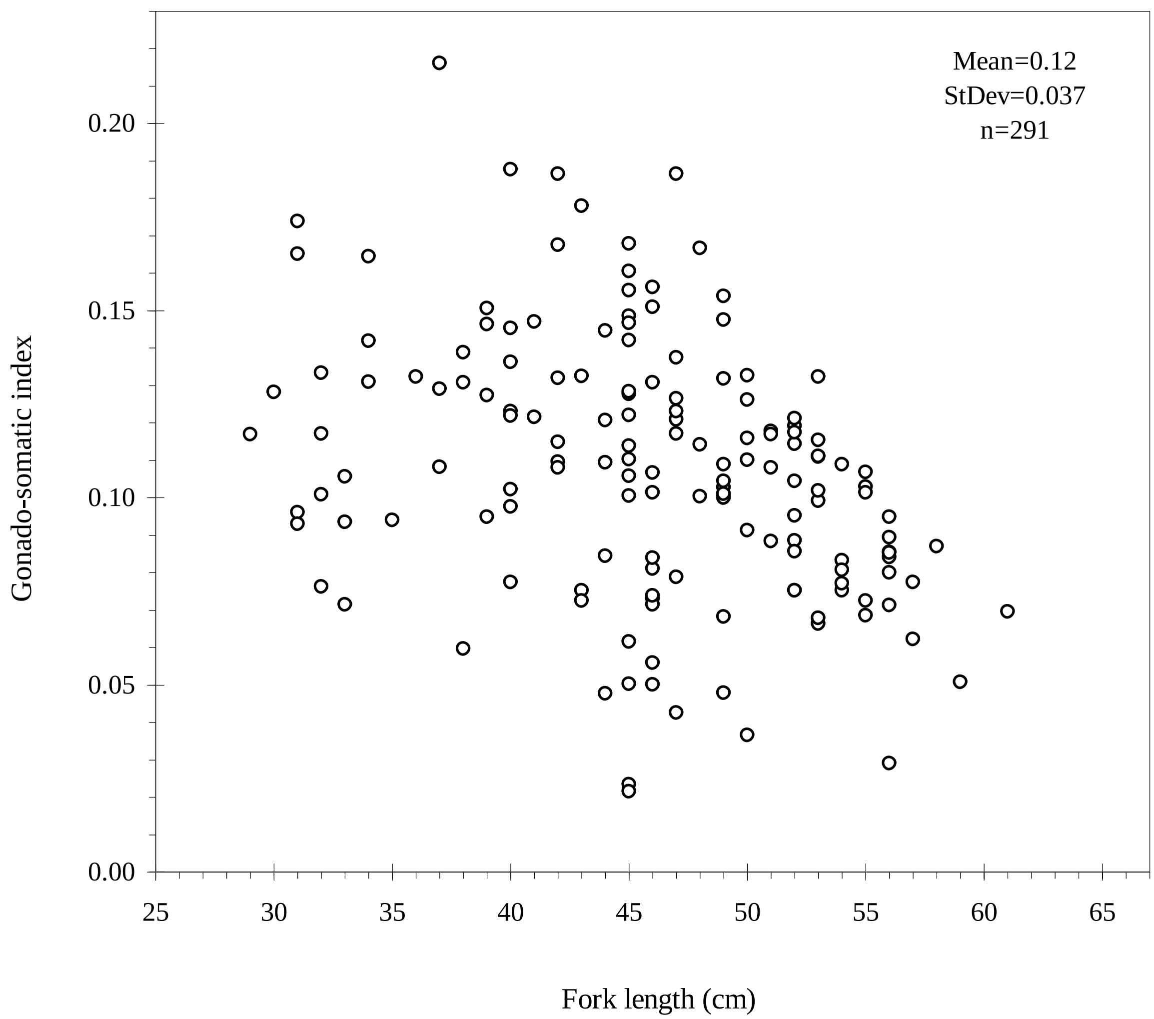

Figure 14. Pollock gonadosomatic index plotted by 1-cm length class for mature females caught during the 2002 echo integration-trawl survey of the Shelikof Strait area.

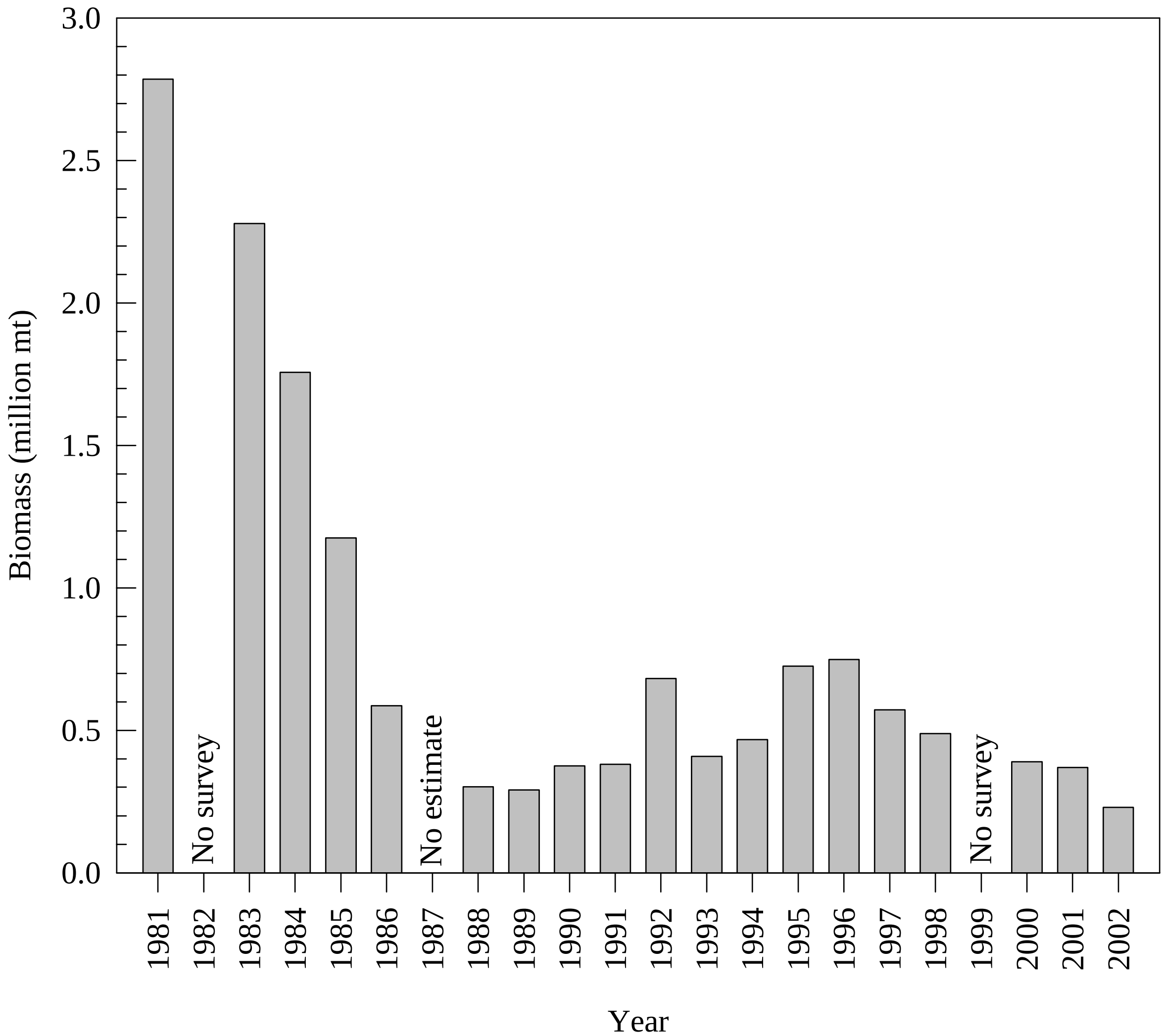

Figure 15. Summary of annual pollock biomass estimates based on echo integration-trawl surveys of the Shelikof Strait area.

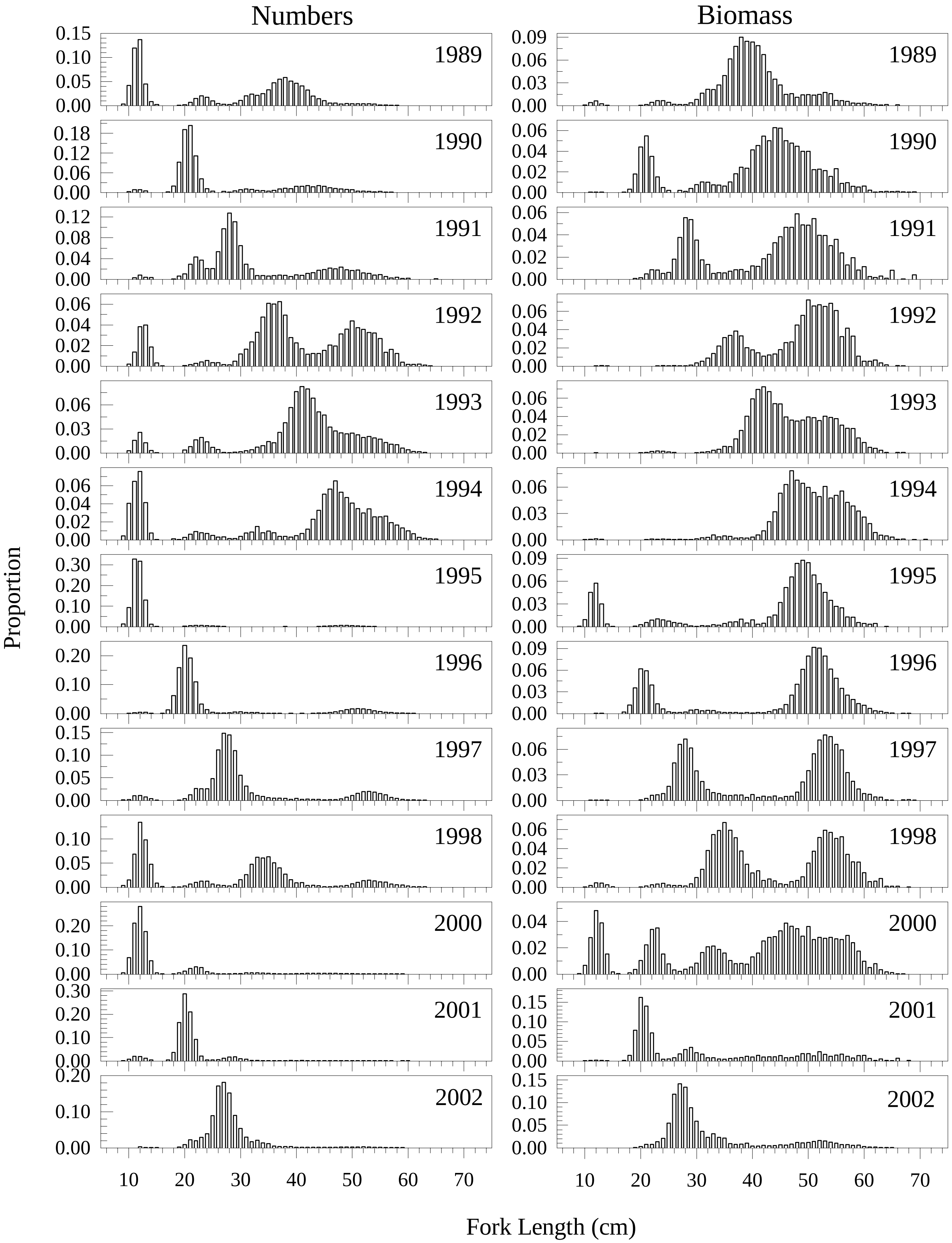

Figure 16. Annual pollock size composition estimates for the Shelikof Strait area based on echo integration-trawl surveys conducted from 1989 to 2002. Note: area was not surveyed in 1999.

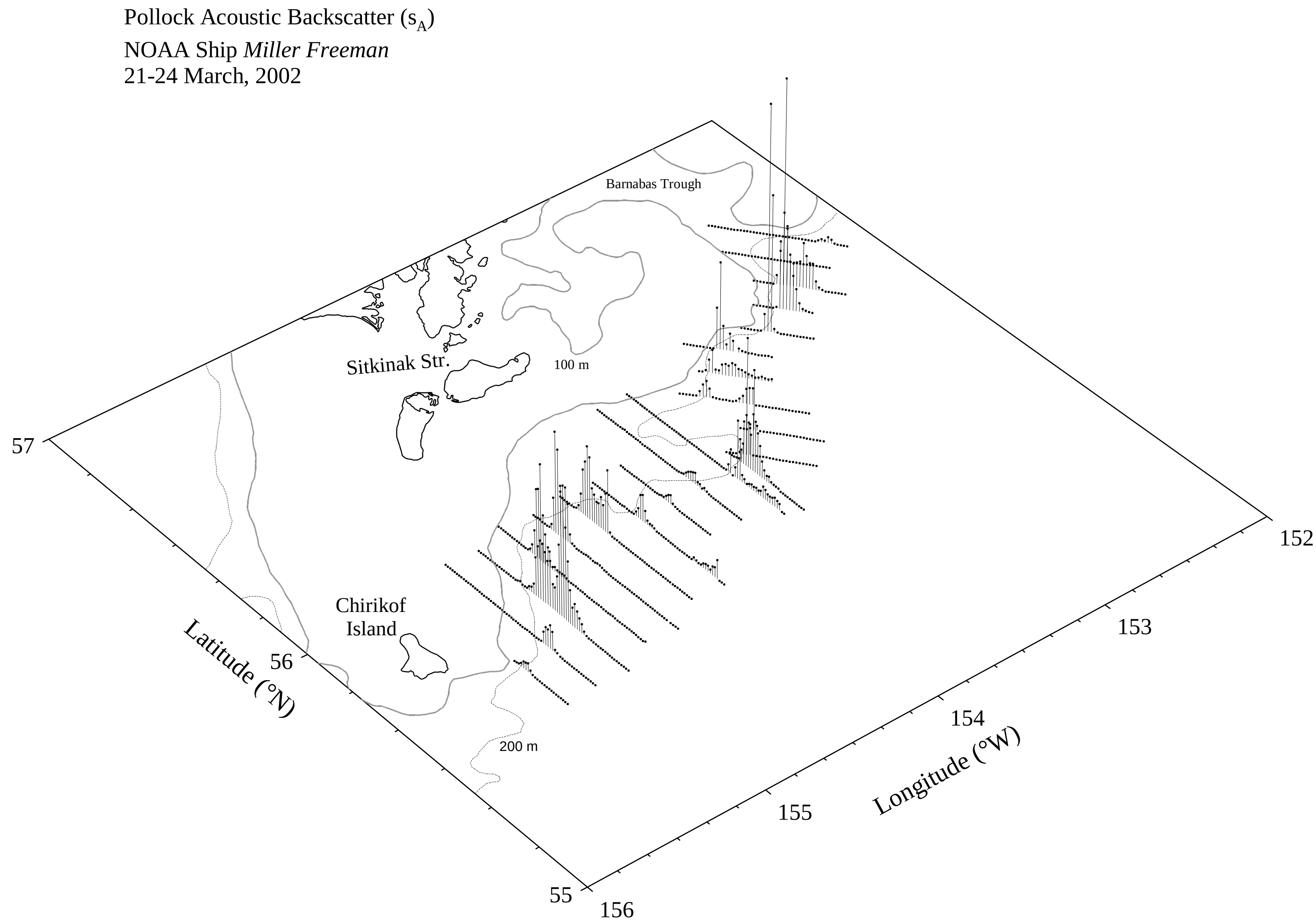

Figure 17. Relative pollock backscatter (s_A) along transects from the 2002 winter echo integration-trawl survey of the Gulf of Alaska shelf break near Chirikof Island.

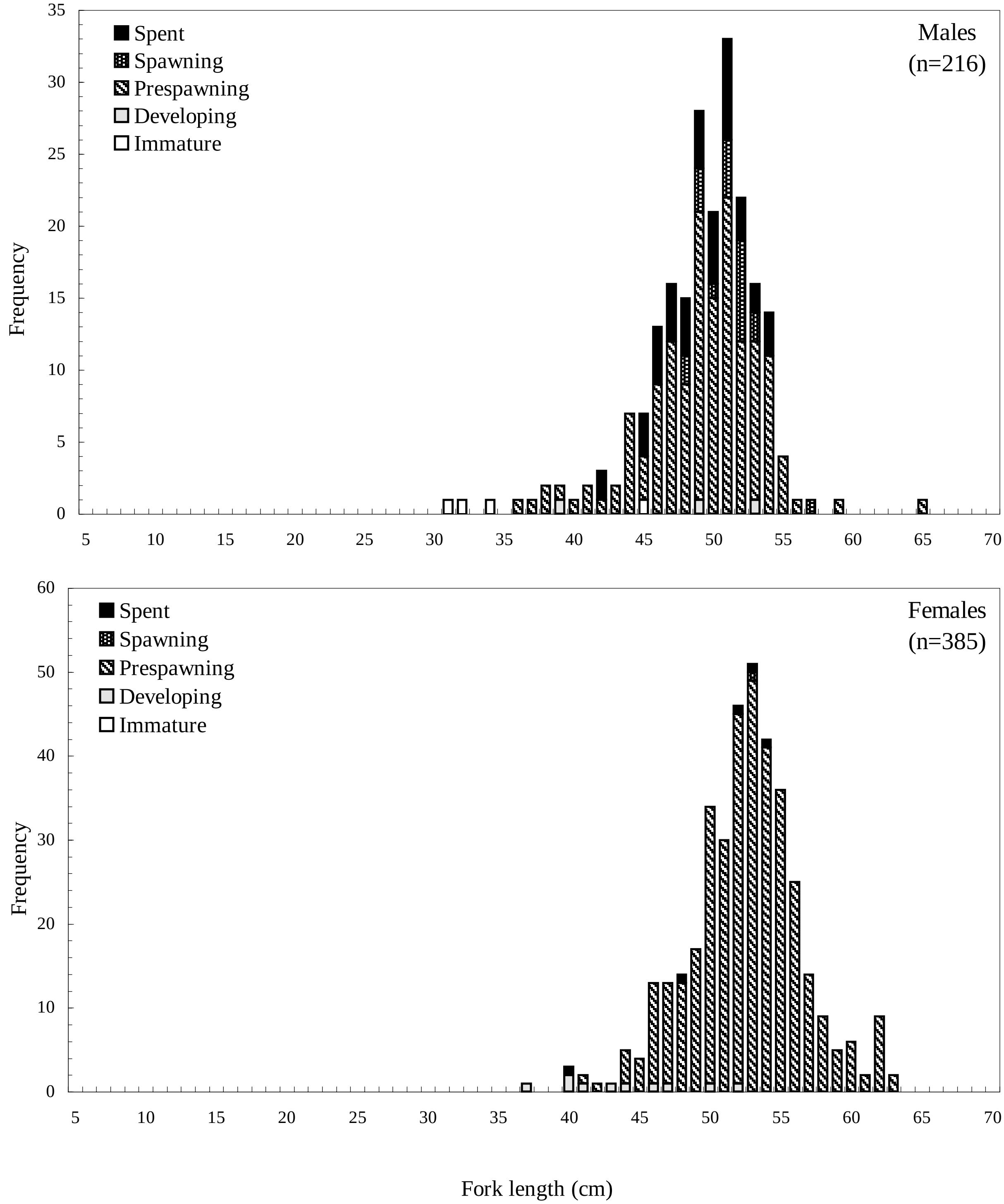

Figure 18. Maturity-length composition for male and female pollock taken during the 2002 echo integration-trawl survey of the Gulf of Alaska shelf break area east of Chirikof Island. The maturity-length composition does not necessarily represent the population size composition.

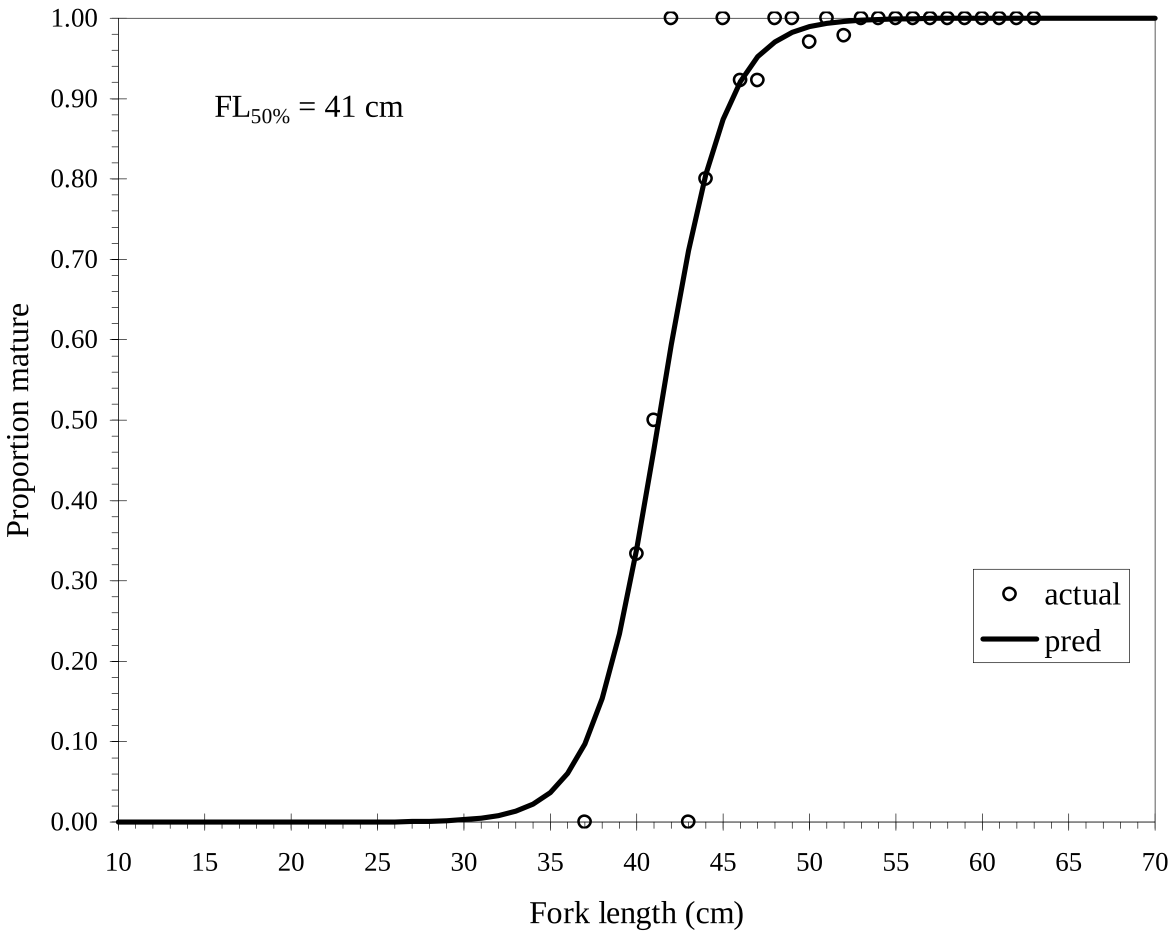

Figure 19. Fitted logistic function and proportion mature at by 1-cm size class for female pollock taken during the 2002 echo integration-trawl survey of the Gulf of Alaska shelf break area east of Chirikof Island.

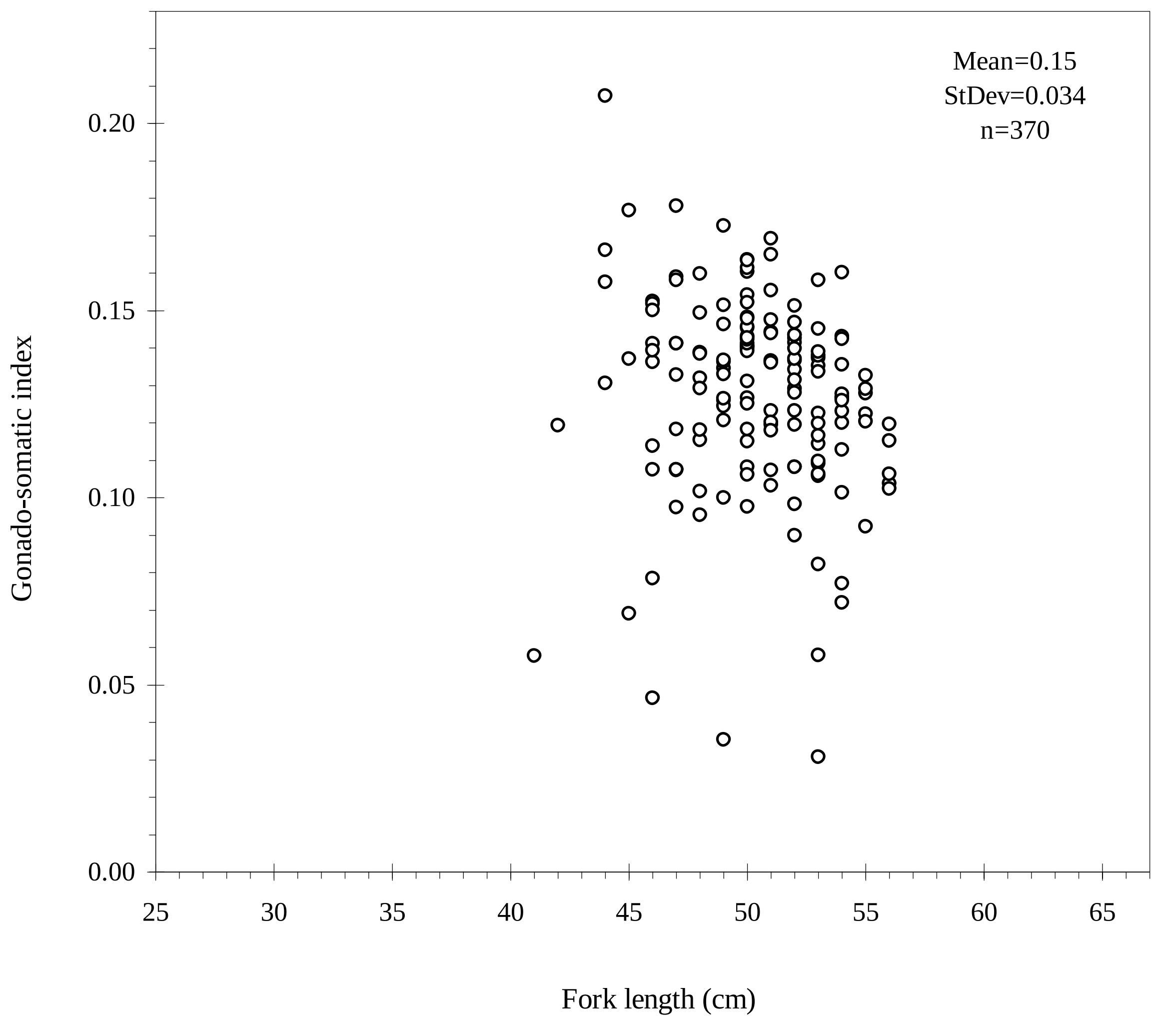

Figure 20. Pollock gonadosomatic index plotted by 1-cm length class for mature females caught during the 2002 echo integration-trawl survey of the Gulf of Alaska shelf break area east of Chirikof Island.

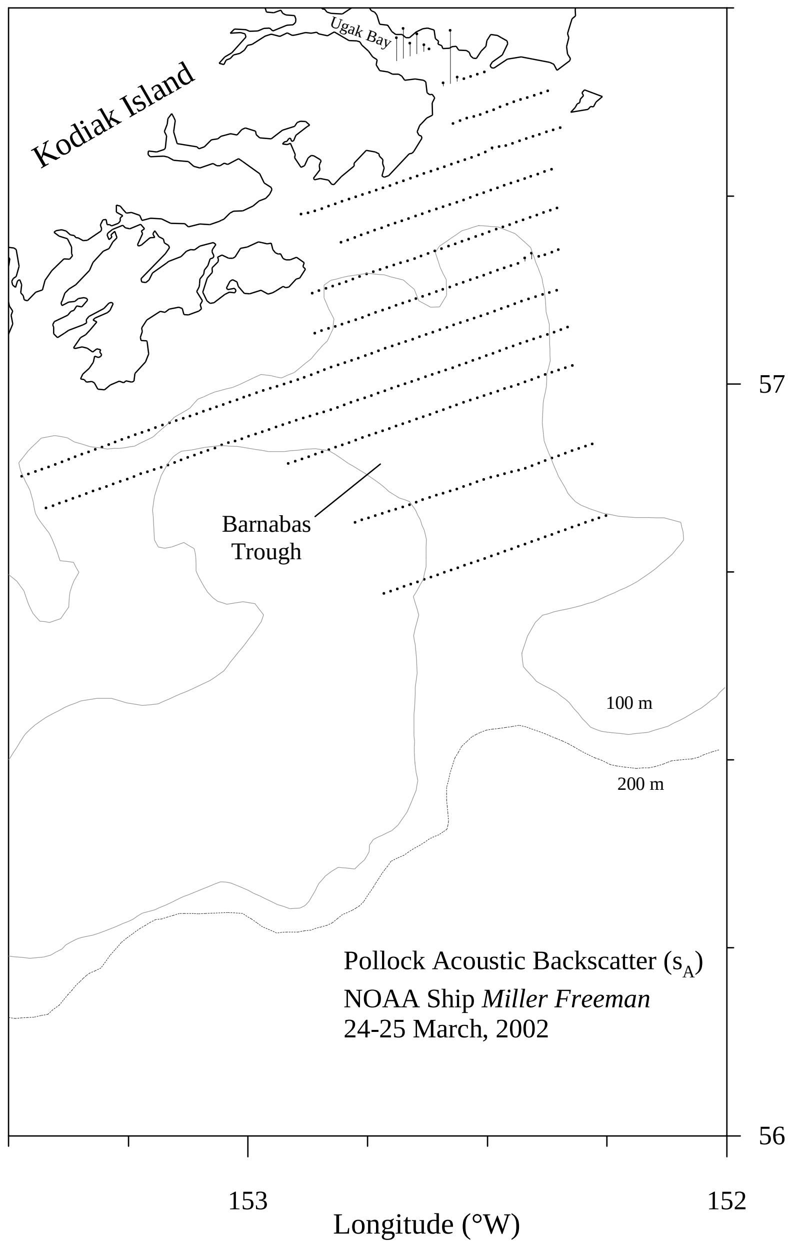

Figure 21. Relative pollock backscatter (s_A) attributed to mid-water layers of primarily subadult pollock along transects from the 2002 winter echo integration-trawl survey of Barnabas Trough.